



ARC Industrial Transformation
Research Hub for
Infrastructure Net Zero



Australian Government
Australian Research Council



MONASH
University

2025

**ANNUAL
REPORT**



ARC Industrial Transformation Research Hub for Infrastructure Net Zero


ACKNOWLEDGEMENTS

The ARC NetZero Hub would like to acknowledge our vital funding by the Australian Research Council. Additionally, for their ongoing financial and in-kind support, we'd like to thank our collaborators: Curtin University, RMIT University, the University of Melbourne, Swinburne University of Technology, University of Technology Sydney, Western Sydney University, University of New South Wales, and the National University of Singapore. We also appreciate the generous contributions of our many industry partners. Assistance from each and every source sustains our quest to advance construction materials and technologies towards net zero. The ARC NetZero Hub is administered by Monash University via the Department of Civil and Environmental Engineering.



Australian Government
Australian Research Council





The journey to net-zero carbon emissions is one of the greatest collective missions of our generation. It challenges us to rethink how we design, build, operate and sustain the infrastructure that underpins modern society. Innovative low-carbon technologies have emerged as a central research focus, advancing infrastructure across its lifecycle. By fostering collaboration between Australia's leading researchers and industry partners, we'll accelerate the development of next-generation technologies for materials, design, construction, operation and maintenance, through digitalisation, artificial intelligence and robotics. At the same time, we'll equip the future workforce with hands-on experience to ensure an impact that lasts well beyond research outcomes. Together we're not only rising to the net-zero challenge - we're shaping the infrastructure of tomorrow.

CONTENTS

01

INTRODUCTION

1.1. Director's Message	6
1.2. About the ARC NetZero Hub	8
1.3. Vision	8
1.4. Mission	8

02

PARTNERSHIPS

2.1. Overview	10
2.2. University Partners	11
2.3. Industry Partners	12

03

DIGITAL TWIN POWERED BY AI AND ROBOTICS

3.1. Overview	16
3.2. AI-Enabled Service-Oriented Digital Twin Framework for Sustainable Infrastructure Management	17
3.3. Development of AI-Desktop-Assistant with Domain-Adaption	18
3.4. Digital Twin Enabled Operation Optimisation of Production Line	19

04

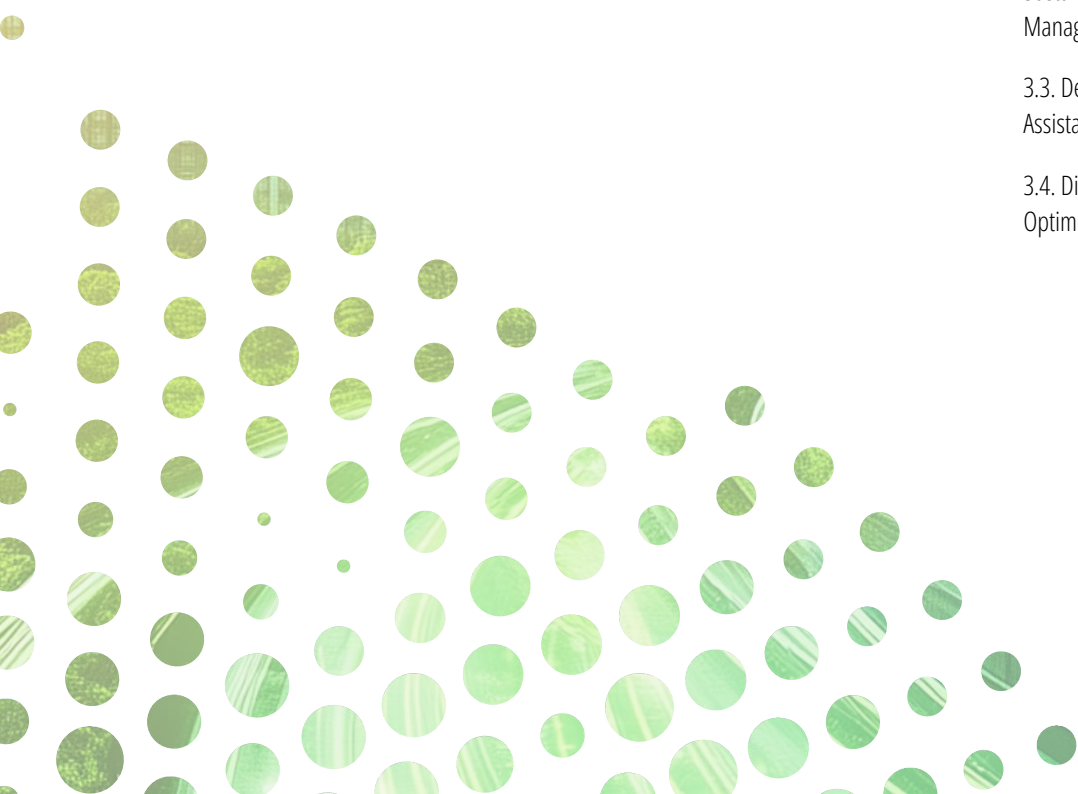
DESIGN OF MATERIALS AND STRUCTURES

4.1. Overview	22
4.2. Predictive Modelling of Soil Behaviour using AI Analysis	23
4.3. Development of Waste-Based Aggregates, Geopolymer Concretes, and Soil Conditioners	24
4.4. Liquefaction of Mine Tailings Mixed with Binder and Cemented Paste Backfill (CPB)	25
4.5. Development of Limestone Calcined Clay Cement (LC3) with Australian Montmorillonite Clay	26
4.6. The Use of Ternary Oxides in Designing Low Carbon Concrete	27
4.7. Sustainable Materials for Construction	28
4.8. Balancing Fire Safety with Net Zero	29

05

CONSTRUCTION

5.1. Overview	31
5.2. High Performance Building System Design	32
5.3. Sustainable Façade System for Improved Thermal Performance	33
5.4. Prototype Digital Twin and AI-Driven Carbon Accounting Platform for Built Assets	34



06

OPERATION & MAINTENANCE

6.1. Overview	36
6.2. ALF 1 Transverse Profiler	37
6.3. Predictive Model for Reliably Estimating Early Age Cracking Potential in Rigid Concrete Pavements	38
6.4. Connected Data and Agentic AI for Sustainable Infrastructure	39
6.5. Development of Robotic Survey and Navigation System in Mining Site	40

07

HUB LAUNCH

7.1. Official Hub Launch	42
7.2. Innovation in Action	43
7.3. Keynotes	44
7.4. Hub Project Showcases	45

08

CELEBRATING OUR PEOPLE AND MILESTONES

8.1. Overview	47
8.2. Hub RA Lays Groundwork for Modular Buildings	48
8.3. Hub HDR Innovates AI Models to Support Geotechnical Practice	49
8.4. Hub Students Present at MicroTAS Conference	50
8.5. A/Prof Pang Sze Dai of NUS Visits Hub	51
8.6. Dr Mesecke Visits Hub and Enhances Int'l Cooperation	52
8.7. Prof Wood Facilitates Discussion on Research Impact on Society	53
8.8. Prof Caijun Shi Hosts Two-Day Workshop	54
8.9. Hub Organises Interdisciplinary Research Initiative Workshop	55

09

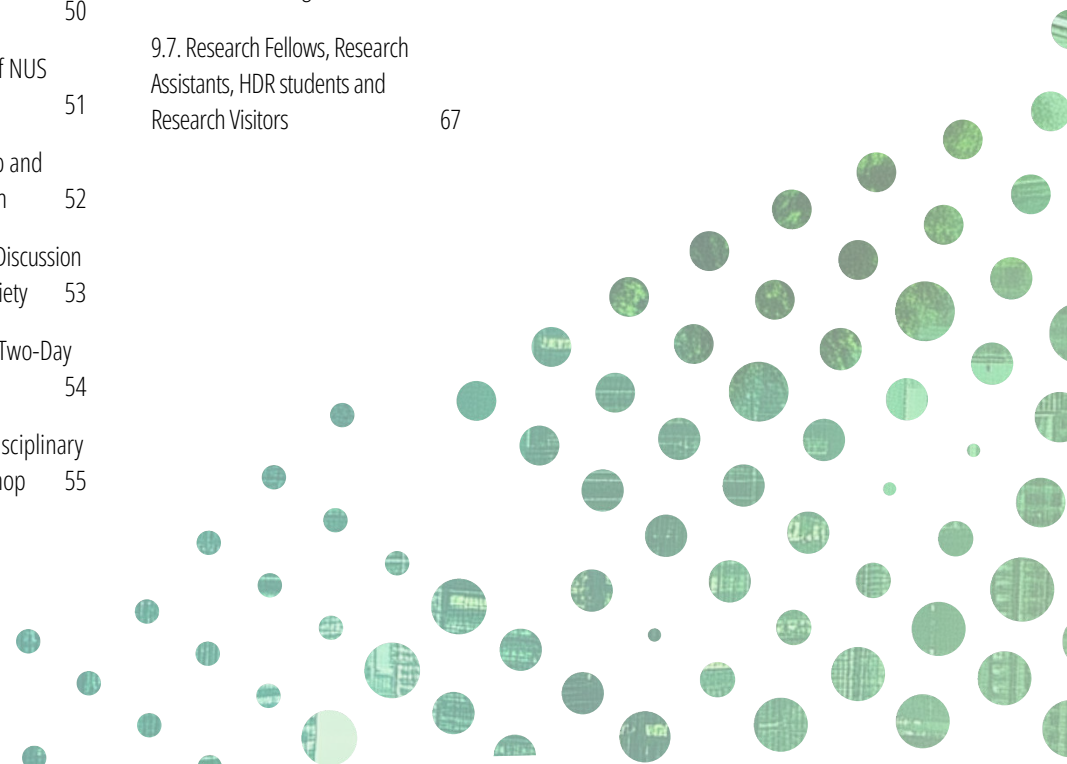
GOVERNANCE

9.1. Overview	58
9.2. Management Team	59
9.3. Advisory Committee	60
9.4. Research, Translation, and Training (RTT) Committee	61
9.5. Chief Investigators	62
9.6. Partner Investigators	65
9.7. Research Fellows, Research Assistants, HDR students and Research Visitors	67

10

PERFORMANCE

10.1. Overview	70
2025 Key Performance Indicators	71



01 INTRODUCTION

1.1. Director's Message

The ARC NetZero Hub has completed its first year of operation with strong foundations in place and clear momentum across research, industry engagement, governance and capability development.

After the official announcement of the Hub on 21 June 2024, our immediate priority was to establish a robust operational and governance framework to support long-term success. Through extensive consultation with chief investigators, partner investigators, industry collaborators and the Monash Research Office, we aligned our strategic objectives with stakeholder expectations and contractual requirements. These coordinated efforts culminated in the successful execution of participant and project agreements, enabling the Hub to

formally commence operations on 21 January 2025.

The Hub has swiftly transitioned from establishment to active delivery. To date, 19 project agreements involving 21 industry partners have been executed, with additional project agreements advancing through finalisation. Research programs are now underway across key thematic areas that focus on integrating artificial intelligence, digitalisation and robotics into materials, design, construction, operation and maintenance. This lifecycle approach positions the Hub to deliver system innovation that supports the infrastructure sector's transition toward net-zero carbon emissions by 2050.

Collaboration is the cornerstone of our model. Throughout the year, we've convened academic

workshops, technical meetings and site visits. These engagements have strengthened cross-institutional alignment, clarified industry needs and reinforced accountability around milestones and deliverables. We've instituted structured reporting systems, financial oversight mechanisms and risk management processes to ensure projects progress in accordance with agreed upon key performance indicators.

The Hub has also prioritised translational impact. From project inception, industry partners and researchers actively engage with each other to define research challenges, guide development pathways and facilitate implementation. This end-to-end engagement model expedites the translation of research outcomes into practice while ensuring responsiveness to real-world constraints and opportunities. Early



Professor Wenhui Duan
Director, ARC NetZero Hub
Monash University



indicators show a strong alignment of research outputs with industry demand.

Capability development is central to the Hub's legacy. Higher Degree by Research students and early career researchers are embedded within multidisciplinary, industry-connected teams. This gives them an opportunity to gain hands-on experience with advanced digital tools and automation technologies, as well as in data-driven decision-making and applied sustainability assessment. By combining research excellence and practical expertise, we're equipping a new generation of professionals to lead the low-carbon transformation of infrastructure systems.

Operational integration across participating organisations has been strengthened by active governance structures, steering and advisory committees and regular cross-node

engagement. Shared access to facilities, coordinated research planning and transparent communication channels have enhanced efficiency and fostered a cohesive national network.

The achievements of our first year reflect the dedication, professionalism and collaborative spirit of our researchers, students, industry partners and professional staff. We celebrated this strong start at the official launch of the ARC NetZero Hub on 17–18 November 2025, where Australian Research Council representatives, university leaders and industry experts recognised our efforts to transform strategic vision to tangible delivery.

As we enter our second year, our focus will shift toward accelerating research outputs, strengthening commercialisation pathways, expanding industry participation and

The Hub has swiftly transitioned from establishment to active delivery. To date, 19 project agreements involving 21 industry partners have been executed, with additional project agreements advancing through finalisation.

delivering measurable environmental and economic impact. We'll continue to track our performance against KPIs, ensure responsible stewardship of resources and maintain the highest standards of research integrity and governance.

The Hub was established to drive vital change across the infrastructure lifecycle. We are now firmly positioned to deliver on our ambition to shape a more resilient, digitalised and sustainable future for Australia's infrastructure.

Wenhui Duan
Director, ARC NetZero Hub

1.2. About the ARC NetZero Hub

Achieving net-zero carbon emissions by 2050 is one of the defining challenges of our time. Australia's national greenhouse gas inventory (2005–2020) underscores the construction sector's impact, with emissions peaking at 180% of 2005 levels in 2018 before moderating to around 150% by 2020. Given that the sector contributes approximately 9% to national GDP and employs around 1.2 million people (2023), decarbonising infrastructure is both an environmental and economic imperative.

Innovative low-carbon technologies have become a central research priority, reflecting the complexity of the infrastructure lifecycle – from materials and design to construction, operation and maintenance. Digital technologies, particularly digital twins, offer a step change in capability by integrating these stages within a unified, data-driven platform.

To deliver on the Hub's mission, we're establishing AI- and robotics-enabled Digital Twin platforms (Theme 1) that anchors three critical lifecycle domains: Materials and Structural Design (Theme 2), Construction (Theme 3) and Operation and Maintenance (Theme 4). This integrated framework enables low-carbon innovation while balancing carbon reduction, cost efficiency and structural resilience.

By streamlining processes across the infrastructure lifecycle, AI and robotics will enhance productivity, optimise energy performance and reduce waste. At the same time, students and early career researchers will gain essential hands-on experience.

Together these efforts position the infrastructure sector to achieve net-zero carbon emissions while sustaining its critical role in Australia's economy.



Professor Alison Ross, ARC Academic Director (left) and Professor Wenhui Duan officially launching the ARC NetZero Hub.

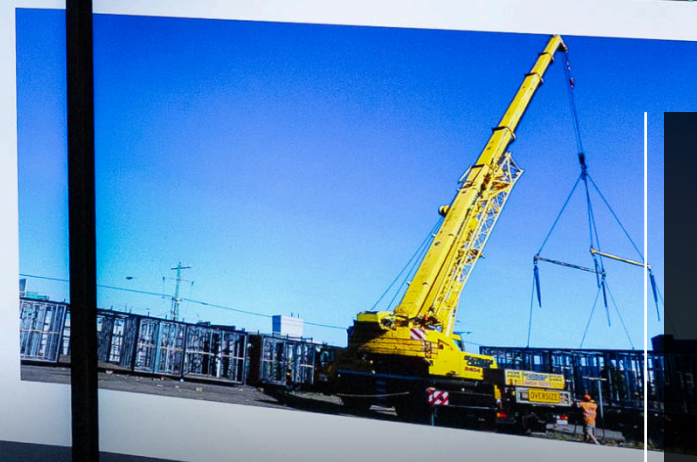
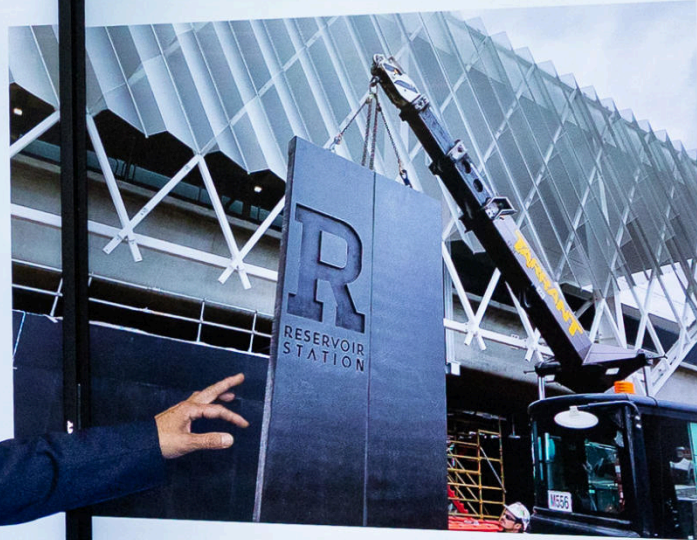
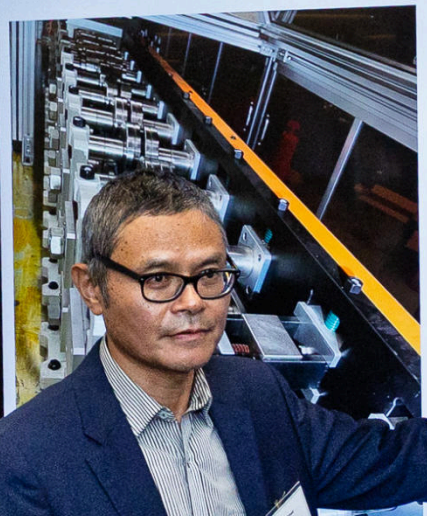
1.3. Vision

As a world-class research centre, the NetZero Hub seeks to transform the Australian construction industry via digitalisation to grow profitability and international competitiveness, while advancing a net-zero goal.

1.4. Mission

By promoting collaboration among Australia's best minds in academia and industry, we aim to advance infrastructure technologies through digitalisation, AI and robotics, while providing hands-on experience to our future workforce.

Australian-Made Excellence in Digital Manufacturing and Modular Construction



The Hub plays a pivotal role in enhancing current collaborations and cultivating new ones with its centralised platform for greater visibility, networking, expertise matching and global outreach.

- iBuild Building Solutions

02

PARTNERSHIPS

2.1. Overview

Researchers from nine partner institutions – eight from Australia and one from overseas – have come together to work on ARC NetZero Hub projects. Monash University is the administering organisation of the Hub, but all partner universities contribute highly skilled researchers to lead projects across our applied research themes.

We're also proud to collaborate with companies at the forefront of innovation in construction technology. Each Hub research project involves an industry partner to ensure our research outputs are business-ready and marketable. This unique collaborative approach is the key to our future success in advancing the infrastructure sector in Australia.

8 Partner Universities

1 Overseas University

21 Industry Partners

2.2. University Partners

The NetZero Hub, drawing upon the expertise of world-class teams from several leading Australian and international universities, has access to top-notch facilities and the best minds. Each team contributes uniquely to the project.



Monash University's participation in the Hub revolves around a smart city infrastructure project under the Australian Government's Smart Cities and Suburbs Program. This project has led to the development of a scalable IoT data platform within the Monash Innovation Labs. The platform supports the access of data from numerous IoT sensors embedded in infrastructure and buildings, and aids in developing digital twins for built environments, mobility and manufacturing processes.



Swinburne Engineering brings its Centre for Smart Infrastructure and Digital Construction into the fold. The Centre is well-equipped with modern facilities, including concrete and structural testing labs, as well as digital construction and geotechnical labs. These facilities, combined with a strong research team, position Swinburne as a vital contributor to the Hub.



The Melbourne School of Engineering offers a high-calibre research environment aligned with the Hub's "smart and sustainable development" focus. The University of Melbourne underscores its commitment to this focus with its upcoming advanced technologies and design campus, as well as its Materials Characterisation and Fabrication Platform, which provides state-of-the-art advanced imaging technologies.



Curtin University's involvement features a digital transformation project funded by industry partners. This project has resulted in the development of the MetaBIM digital engineering platform, which integrates lifecycle assessment approaches for built asset lifecycle emissions. Such capabilities are crucial for the Hub's sustainability focus.



UNSW contributes its Pyrometric Lab at its ADFA campus, providing advanced thermal analysis capabilities. Additionally, its Mark Wainwright Analytical Centre offers comprehensive facilities for material examination, supporting the Hub's research in material science. The collective resources and expertise from these institutions provide the Hub with an unparalleled research environment.



Ranked first in the Times Higher Education 2023 rankings, WSU brings to the Hub a rich research culture and well-equipped laboratories. These facilities enable testing of construction materials and structures under various conditions, supporting the development of digital twins for smart homes.



RMIT's Department of Civil & Infrastructure Engineering contributes its advanced materials and structures laboratory at its Bundoora campus. This facility boasts contemporary equipment for structural testing and durability analysis, along with non-destructive testing, bolstering the Hub's research with essential technical support.



UTS equips the Hub with advanced structural testing facilities, including a notable shake table facility. The expertise of academic and support staff at UTS is pivotal to research impacting the utilisation of industrial by-products and the development of sustainable concrete structures.



NUS contributes to the Hub top international experts in structural reliability simulations, structural health monitoring & smart materials and structural dynamics & protective technology.

2.3. Industry Partners

The establishment of the NetZero Hub attests to the strong commitment of national industry leaders, who recognise the urgent need to integrate AI into the construction sector and are eager to collaborate with university researchers to achieve this.

These industry partners recognise the Hub as a critical addition to the R&D landscape, bridging gaps in commercial access and enabling a reciprocal flow of innovation. Beyond financial support, they contribute expertise and strategic engagement, strengthening the Hub's intellectual environment and impact. Thanks to this collective investment of resources and knowledge, the Hub is set to be a driving force in research and industry transformation across Australia.



AIBUILD positions itself as a professional provider of innovative solutions. Over the last five years, it has developed big data and software solutions for Australian industries, ranging from supply chain management and real estate to education and research. AIBUILD helps enterprise clients reduce costs and improve consistency in their processes with AI and virtual reality (VR) technology.



iBuild Building Solutions, a leading provider of pre-fabricated structures, boasts exceptional prowess in design, research & development, and manufacturing. Its diverse product range encompasses kit homes, modular buildings and steel structures. In the last fiscal year, it successfully completed over 100 housing projects and it's now poised to double that number in the current financial year.



Contegrity is an Australian construction firm in Noble Park, Victoria. For more than a decade, it has operated with a deep commitment to quality, dependability and efficiency. Forever breathing life into its mission – 'constructing with pride and integrity' – Contegrity has attained an annual turnover of more than 5.3 million.



Intrax Consulting Group is a leading multi-disciplinary engineering consultancy with 10 locations across Australia. As a company that values innovation and pioneers in the residential construction space, it has been classifying soil per AS2870 for residential structures at over 12,000 sites annually. At the Hub, the group is exploring how AI can revolutionise the prediction of soil characteristics, moving beyond its current practices.



Vivistand is a Melbourne company dedicated to ergonomic equipment. It has been committed to the design and development of user-friendly workplace devices since 2019. With proven success in designing and developing a variety of motorised devices for customers who work remotely around the world, Vivistand has honed its new vision for intelligent interactive platforms in future workplaces.



Star Combo Pharma, established in Sydney in 2004, is a leading manufacturer and distributor of premium health and natural beauty products. The company has consistently demonstrated double-digit annual growth since its inception, with an annual turnover of 16 million in 2022. With its skilled workforce, it upholds its mission of enhancing customer health through high-quality, naturally-derived nutraceutical products.



Founded in 1993, Nu-Rock Technology is a Sydney-based supplier of construction materials and products in Australia. The company pursues excellence and innovation to provide novel solutions to the pressing problem of industrial by-products. An award-winning waste site remediation company, Nu-Rock has the technical capability to permanently transform industrial waste sites into green sites, and convert waste into a range of sustainable building products.



Knox City Council is a local government in the eastern suburbs of Melbourne, and serves over 165,000 residents. Council currently has more than 723 full-time employees. Dedicated to managing greenhouse gas emissions and responding to climate change, it has developed the Climate Response Plan 2021-2031, which sets out a pathway and actions to help the community reach net-zero emissions by 2040.



As a leading authority in the transport sector, the National Transport Research Organisation (NTRO) is developing new knowledge, innovation, standards and specifications for moving people and freight in Australia and New Zealand. It offers innovative research and practical solutions to integrate planning, operations and research across all modes of transport including roads, rail, ports and airports. NTRO strives to secure resilience for our national transport future.

VETALI ENGINEERS

Vetali Engineers is a leading structural engineering organisation specialising in facade engineering. As a consultancy, Vetali provides tailored solutions for all types of facade system development, validation, production phase engineering, wind engineering, corrosion engineering and material engineering. Vetali's annual sales revenue totals \$1 million.

Adelaide Holdings

Founded in 2016, Adelaide Holdings is an Adelaide-based construction and technology company that applies systemic approaches to remove unnecessary time and costs in building design and construction, and thus increases the efficiency of modern construction. It has more than a couple million bookings for new construction in the standard family housing, student housing and renovation sectors.



Geoengineering Solutions and Services (GeoSAS) is a consulting company for the mining industry in Australia. Its main mission is to provide world-class services in different areas, including mine design and feasibility, geotech analyses, cost optimisation, and mine planning and scheduling, with a major focus on rock engineering aspects of the projects.



In 1991, the Ash Development Association of Australia (ADAA) formed to foster economic market opportunities for the use of coal combustion products commonly known as power station ash, fly ash or furnace bottom ash. The ADAA is committed to facilitating the responsible beneficiation and utilisation of coal combustion products as valuable materials across various industry sectors. To this end, it primarily focuses on construction materials.



The Australasian (iron & steel) Slag Association was formed in 1989 by a group of leading steel, cement, quarrying and slag processing companies. The group aims to increase community, business and government awareness of the superior construction properties and the environmental and value-added benefits of various iron and steel furnace slags.



In 2018 a group of natural and manufactured pozzolan supply chain producers, processors and users formed the Australasian Pozzolan Association. The term 'pozzolan' was adopted into the association's name as it most accurately reflected the material characteristics of interest to the founding members, and differentiated it from associations with an interest in materials such as cement, lime, amorphous silica, slag or coal ash.



Bestech Australia Private is an Australian private company headquartered in Dingley Village, Victoria. Established in 2002, Bestech is a leading supplier and manufacturer of sensor, instrumentation and teaching equipment in Australia, New Zealand and other Pacific nations. In addition, Bestech is an exporter of Sealtick, a package integrity tester manufactured in Australia and exported worldwide.



TERREQUIP
REGENERATIVE MINING

Founded in 2018, Terrequip Mining is a Queensland-based company specialising in regenerative mining, mine rehabilitation and mine closure. It creates better outcomes through the innovative repurposing of natural resources, with an aim to develop a sustainable future for mines, communities and the environment. The company operates active mines to responsibly extract a range of commodities, such as bentonite, limestone and kaolin, minimising environmental impact and contributing to the circular economy.



Orica is one of the world's leading providers of mining and infrastructure solutions. From the production and supply of explosives, blasting systems, specialty mining chemicals and geotechnical monitoring to its cutting-edge digital solutions and comprehensive range of services, it sustainably mobilises the earth's resources. Founded in 1874 as a supplier of explosives to the Victorian goldfields in Australia, Orica has grown to become a prominent publicly-owned company on the Australian Stock Exchange.



Transport for NSW (TfNSW) is strongly committed to achieving net-zero emissions, with a focus on enhancing the environmental sustainability of road construction materials. TfNSW recognises the potential to drive transformative changes in industry specifications and policies through research and development, and it's committed to contributing resources and support to ensure the achievement of sustainability goals.



Recognised as one of Queensland's largest local governments, Sunshine Coast Council was established in 2008, merging several local councils to enable a transformative regional approach. As of 2022, the region's Gross Regional Product (GRP) was valued at \$18.5 billion, reflecting a significant economic growth of 34% over the past decade. Future projections estimate its GRP will reach \$33 billion by 2041. Its goals include promoting sustainable development, economic growth and technological innovation while preserving the region's natural and cultural assets.



Established in Melbourne in the early 1980s, the Advanced Precast group of companies has grown to become one of Australia's leading precast concrete providers in the building sector. Today it is recognised as a Master Precaster by the National Precast Concrete Association Australia. With four decades of experience, its in-house engineering, detailing, manufacturing and construction teams have consistently delivered innovative and cost-effective precast solutions for building structures, setting industry standards and leading by example.



AGNICO EAGLE
Agnico Eagle Mines produces precious metals from operations in Canada, Australia, Finland and Mexico. It has a pipeline of high-quality exploration and development projects in these countries, as well as in the United States and Colombia. As the largest gold producer in Victoria, the Fosterville Gold Mine (Agnico Eagle Australia) is a high-grade, low-cost underground gold mine 20 km from Bendigo and 130 km from Melbourne. The Fosterville Mine features highly profitable gold production, as well as extensive in-mine and district-scale exploration potential.



ERP

Advanced AI technologies can increase productivity and improve management of digital construction and sustainable supply chains – important components of infrastructure sustainability.

– AIBUILD

03

DIGITAL TWIN POWERED BY AI AND ROBOTICS

3.1. Overview

This theme aims to develop a generic digital twin (DT) framework for infrastructure systems. It entails the development of a robotic AI system for digital modelling in infrastructure and a smart multi-sensory network for real-time synchronisation and reasoning, as well as advanced robotic systems for implementing decisions from the digital model with an emphasis on hardware development.

The main focus is on improving consistency and interoperability in the crafting and exploitation of DT platforms. This, in turn, leads to efficient collaboration, effective integration and broad applicability in infrastructure system design, while moving towards net-zero emissions.

This theme consists of three main research programs:

Hub CI, Dr Yihai Fang (Monash University), demonstrates how digital-twin and AI-driven vehicle impact simulations improve construction safety and maintenance operations.



- **Program 1:** AI-enabled service-oriented DT framework (digital world generated from physical space)
- **Program 2:** Intelligent sensor network for DT synchronisation (from physical world to digital world)
- **Program 3:** Robotic implementation based on DT decision (from digital world to

physical world)

Intended outcomes: development of DT framework; implementation of a DT system for smart human-robot collaboration and efficiency optimisation of production lines; creation of smart multi-sensory system to monitor structural health for infrastructure management; implementation of automated robotic systems in construction and infrastructure monitoring.



3.2. AI-Enabled Service-Oriented Digital Twin Framework for Sustainable Infrastructure Management

INTRODUCTION

Construction continues to face productivity issues, cost overruns and growing net-zero demands. Enterprise Resource Planning (ERP) systems support operations, but will continue to lack integrated sustainability decision support as long as digital tools remain fragmented. This research aims to develop an ERP-enabled probabilistic framework that unifies sustainability assessment and optimises cost-benefit for construction projects.

METHODS

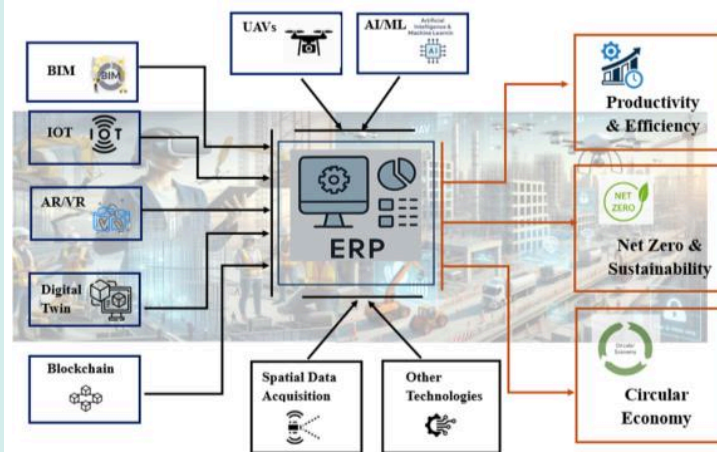
1. Integrate sustainability and financial criteria to form cohesive project KPIs.
2. Model uncertainty using Monte Carlo, FORM and Bayesian updating.
3. Develop ERP dashboard for probabilistic, data-driven decision support.

OUTCOMES

Current ERP adoption in construction is fragmented, with sustainability assessment and financial evaluation treated separately. Digital technologies remain siloed, and probabilistic uncertainty is rarely considered. These gaps underscore the need for a unified ERP-enabled probabilistic framework to link sustainability and cost-benefit decision-making.

This project aims to seamlessly integrate the ERP system with a digital twin framework, providing real-time insights, predictive analytics and decision support for infrastructure management.

Prof Lihai Zhang (University of Melbourne) collaborates with AIBUILD to build a framework that integrates digital technologies into Enterprise Resource Planning to address construction lifecycle challenges.



TEAM

CI: Prof. Lihai Zhang (lihzhang@unimelb.edu.au);

Dr. Shuangmin Shi;

Dr. Boran Zhang;

Mr. Sachintha Thejan.

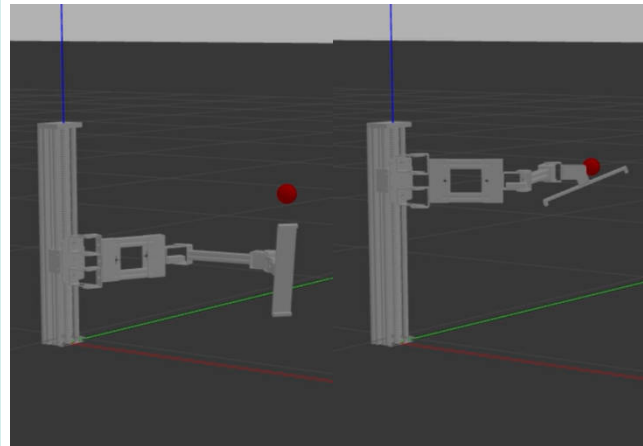
PI: Mr. Yifei Wang





3.3. Development of AI-Desktop-Assistant with Domain-Adaption

A/Prof Chen (Monash University) collaborates with AUIC (Vivistand) to develop intelligent assistant robots that adjust their movements based on user behaviour. The image shows the arm performing real-time obstacle avoidance using the Artificial Potential Field (APF) method.



INTRODUCTION

The development of AI-powered desktop robot assistants has garnered significant attention in recent years due to advancements in artificial intelligence, natural language processing and robotics. These assistants are designed to streamline user interactions by performing various tasks, while also providing personalised assistance tailored to the user's needs.

Unlike traditional software-based virtual assistants, desktop robot assistants offer a tangible, physical interface that enhances engagement and interactivity.

METHODS

1. Multi-functional environmental perception network: This creates an adaptable network capable of generalising across diverse application scenarios.
2. Imitation and reinforcement learning for hybrid learning: This combines imitation learning for behaviour mimicry and reinforcement learning for performance optimisation.
3. Long-term learning with network compounding: This sustains performance growth and handles increasingly complex tasks over time.

OUTCOMES

The team will first develop a highly adaptive AI model with semantic understanding to operate in different environments, and then ultimately develop both hardware and software for an AI-enabled desktop assistant.



TEAM

CI: A/Prof. Chao Chen (Chao.Chen@monash.edu)

Dr. Shao Liu

Dr. Hanwen Kang

Mr. Chunyu Jiang

Mr. Edric Lay

PI: Mr. Li Xu





3.4. Digital Twin Enabled Operation Optimisation of Production Line

INTRODUCTION

This project aims to develop a service-oriented digital twin system for the Australian manufacturing sector. The system provides a modular framework that connects real-time production data with AI-driven sustainability analytics. It enables manufacturers to monitor/optimize overall equipment effectiveness (OEE), yield and CO₂ emissions, identify root causes of inefficiency, and improve operational performance. The expected outcome is a replicable digital manufacturing model that advances the transition to net-zero production.

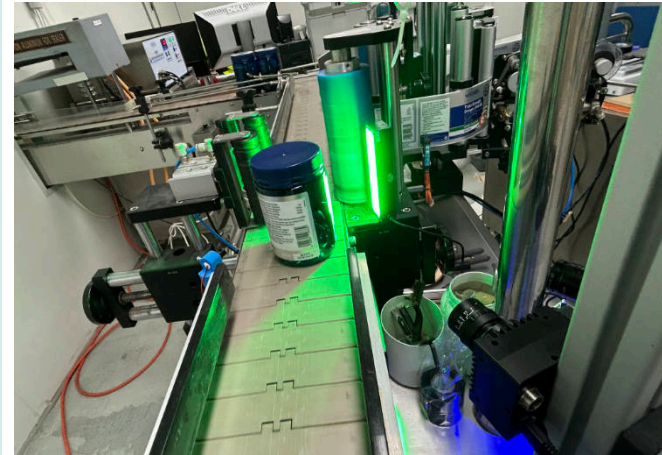
METHODS

1. Service-oriented architecture built on inter-operable microservices for data analysis.
2. Modular design with plug-and-play components adaptable to different production lines.
3. Customisable digital twin models for process stages.
4. AI-driven analytics for real-time computation of OEE, yield and CO₂ metrics.
5. Unified dashboard for real-time visualisation of performance and sustainability indicators.

OUTCOMES

Pilot studies using a live digital twin of Star Combo's production line have enabled a 10% to 15% reduction in energy use and CO₂ emissions. The ultimate goal is to create a scalable digital infrastructure for ongoing net-zero transformation.

Dr Yunlong Tang (Monash University) works with Star Combo to develop a framework for the implementation of service-oriented digital twins in production lines. In this image, the framework includes sensor systems integrated into production lines for product defects detection.



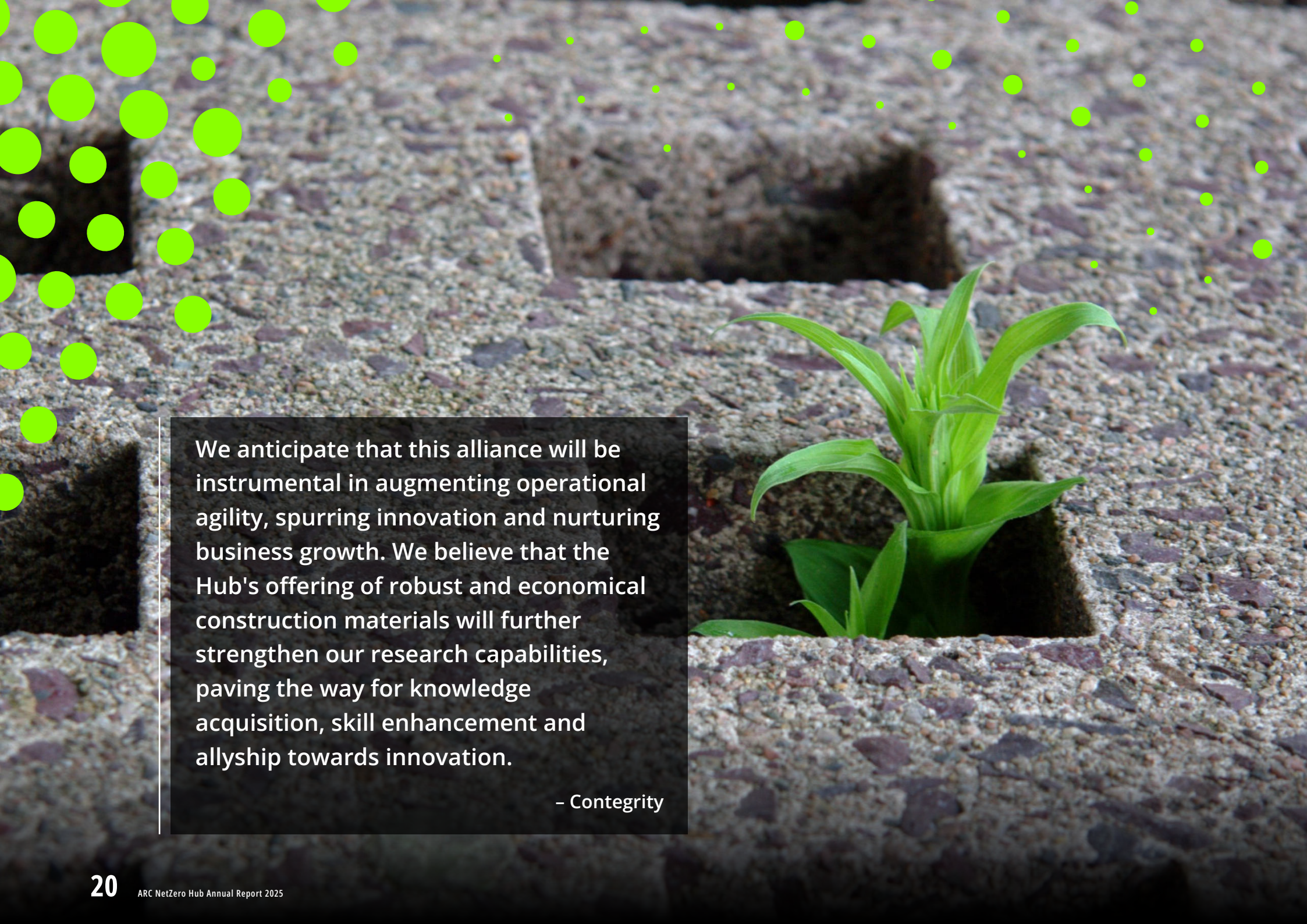
TEAM

CI: Dr. Yunlong Tang (Yunlong.Tang1@monash.edu)

Mr. Sri Sri Shantha

PI: Mr. James Ni





We anticipate that this alliance will be instrumental in augmenting operational agility, spurring innovation and nurturing business growth. We believe that the Hub's offering of robust and economical construction materials will further strengthen our research capabilities, paving the way for knowledge acquisition, skill enhancement and allyship towards innovation.

- Contegrity

netzero | ARC Research Hub for Infrastructure Net Zero

Predictions

RMIT UNIVERSITY | **Intrax**

Predictive Modelling of Soil Behaviour using AI analysis

Machine learning models to guide geotechnical professionals in design and decisions

INTRODUCTION

While the industry bears a significant cost in this site investigation phase, the reliability of the adopted input design parameters are still born by significant uncertainties due to non-soil homogeneous behaviour and limited test data driven by expensive on-site/lab testing. With the evolution of machine learning (ML), opportunities have arisen to redefine our approach to understand soil behaviour, obtain design parameters and predict its response under loading. This project aims to utilize cutting edge ML models to support our understanding and predictive capability of soil behaviour.

METHODS

Data will be collected from the industry partner's database and from literature to capture the behavioural characteristics of different soil types. Image recognition techniques will be used to stage of data analysis and classification, shallow models will be further deployed for basic soil classification. Further, deep learning architectures, will be explored for advanced analysis.

OUTCOMES

A detailed database capturing Australian soils and their geotechnical properties. ML models capable of classifying and predicting soil behaviour. Innovative tools to guide geotechnical professionals in their designs and decisions.

TEAM

Dr. Pratik Shah, Robert O'Brien, Pratik Shah, Pratik Shah, Pratik Shah

The successful implementation of AI in soil characterisation will have far-reaching implications, not only for Intrax and our customers, but for the broader community. We foresee long-term economic, commercial, social and environmental benefits, including improved design accuracy and a need for fewer resources for manual tests.

– Intrax Consulting Group

04

DESIGN OF MATERIALS & STRUCTURES

4.1. Overview

This theme aims to deploy AI tools in the global development of new materials and the design of structures. The main programs include AI-driven classification of Australian soil, optimisation of life cycle costing based on machine learning, AI-assisted design of limestone calcined clay cement-based composite structural panels, and development of sustainable solar roof tiles for smart residences through a DT framework. This theme consists of four research programs:

- **Program 1:** AI-driven classification of Australian soil for geotechnical engineering applications
- **Program 2:** Low-carbon concrete design optimisation and application using machine learning

- **Program 3:** Integrating AI into deployment of sustainable LC3-based composite structural systems
- **Program 4:** Harnessing AI in the development of self-repairing, sustainable roof tiles with efficient photovoltaic integration

Intended outcomes: adoption of the latest AI technologies to assist the development of low-carbon construction materials and net-zero infrastructure systems – the demonstration of practical smart home roofing and sensor system prototypes will facilitate this.

Mr Sachin Silva, Hub PhD candidate at RMIT University (CI Prof Dilan Robert) discusses the development of AI-driven predictive models for soil behaviour at the ARC NetZero Hub Grand Challenges in Civil Engineering Workshop.





4.2. Predictive Modelling of Soil Behaviour Using AI-Driven Analysis

INTRODUCTION

While the industry bears a significant cost in this site investigation, the reliability of design parameters remains subject to significant uncertainties. This is due to non-soil homogeneous behaviour, and limited test data (on-site/lab testing can be expensive).

With the evolution of machine learning (ML), opportunities have arisen to redefine how we understand soil behaviour, determine design parameters and predict soil response under loading. This project aims to utilise cutting-edge ML models to support our understanding and ability to predict soil behaviour.

METHODS

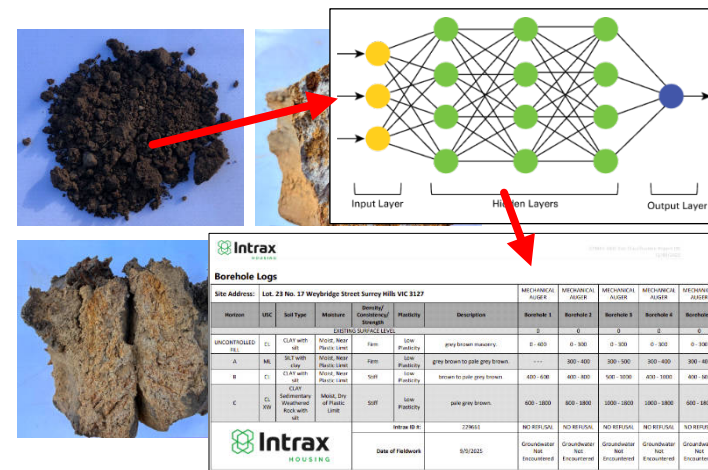
Data will be collected from the Intrax database and research literature to capture the behavioural characteristics of different soil types.

Image recognition techniques will be used to evaluate soil image classifications. In the next stage of data analysis and classification, shallow models will be deployed for basic soil classification. Further, deep-learning architectures will be explored for advanced analysis.

OUTCOMES

The project aims to create a detailed database capturing Australian soils and their geotechnical properties, ML models capable of classifying and predicting soil behaviors, and innovative tools to guide geotechnical professionals in their designs and decisions.

Prof Dilan Robert (RMIT University) collaborates with Intrax Consulting Group to develop AI-models based on image classification that can predict soil properties and guide geotechnical professionals in design and decisions.



TEAM

CI: Prof. Dilan Robert (dilan.robert@rmit.edu.au);

Mr. Sachin Deelaka Silva

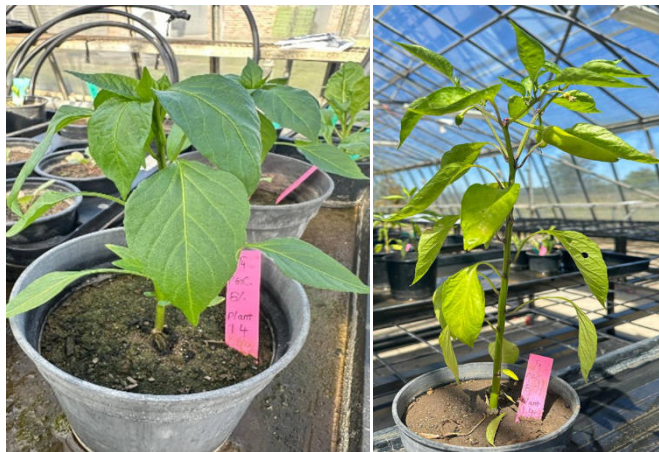
PI: Mr. Nigel Guo





4.3. Development of Waste-Based Aggregates, Geopolymer Concretes, and Soil Conditioners

Western Sydney University team led by Prof Zhong Tao collaborates with Terrequip to transform their waste materials into greener, better-performing construction products. Images show field trials carried out with the developed soil conditioners.



INTRODUCTION

Terrequip has been seeking more affordable, better-performing and genuinely green building products for decades. This project aims to develop value-added aggregates, geopolymer concretes and soil conditioners by incorporating a high volume of waste materials, such as quarry dust and red mud.

METHODS

1. Properties of waste materials and binders are greatly affected by the size of their particles, chemical composition and processing method. Therefore, all waste materials and binders will be thoroughly characterised.
2. Value-added aggregates, geopolymer concretes, and soil conditioners will be developed by incorporating a high volume of waste materials.
3. The waste-based products will be characterised to ensure all relevant standards are met, and they'll be compared to relevant commercial products.
4. After new products are developed, a lifecycle analysis will be conducted to evaluate the cost and environmental impact.

OUTCOMES

The team will assist Terrequip in developing value-added products from waste materials. By contributing to a sustainable society with an aim of zero waste and zero greenhouse gas emissions, the project will help Australia achieve its net-zero goal by 2050.



TEAM

CI: Prof. Zhong Tao
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Dr. Michelle Mak;

Dr. Md Abdul Alim;

Dr. Utsab Katwal;

Mr. Yang Liu;

Mr. Sandali;

Dr. Adrian Renshaw;

PI: Mr. Shane Leary





4.4. Liquefaction of Mine Tailings Mixed with Binder and Cemented Paste Backfill (CPB)

INTRODUCTION

Enhancing the production quality of cemented paste backfill (CPB) in mining operations is critical to reducing CO₂ emissions. However, significant challenges remain in optimising mix designs while maintaining consistent mechanical performance.

To address this, CPB formulations can be refined to reduce cement content while preserving or enhancing their mechanical strength and durability. In parallel, the injection and sequestration of CO₂ within CPB presents a promising pathway to further lower the carbon footprint of backfilling operations.

METHODS

1. Laboratory CPB mix design optimisation is undertaken to reduce cement content while maintaining required mechanical performance.
2. Carbon mineralisation is evaluated as an alternative approach, involving the injection of CO₂ into the paste for permanent storage within the matrix. This method enables effective carbon sequestration.

OUTCOMES

A new mix design will be developed to reduce cement consumption while enhancing the mechanical performance of the paste. Direct injection of CO₂ into the paste is also being explored as a carbon capture strategy aligned with net-zero emission targets. A deeper understanding of these approaches is expected to optimise CPB performance, improve mine safety and support more sustainable mining practices.

A/Prof Hossein Masoumi of Monash University, in collaboration with GeoSAS, advances innovative approaches to enhance the performance of cemented paste backfill (CPB) — material used to safely fill mined-out voids — to help reduce environmental impacts in mining.



TEAM

CI: A/Prof. Hossein Masoumi (hossein.masoumi@monash.edu)

Dr. Mohammadreza Aghajanzadeh

Mr. Amir Mohamadi

Mr. Goran Shirzad

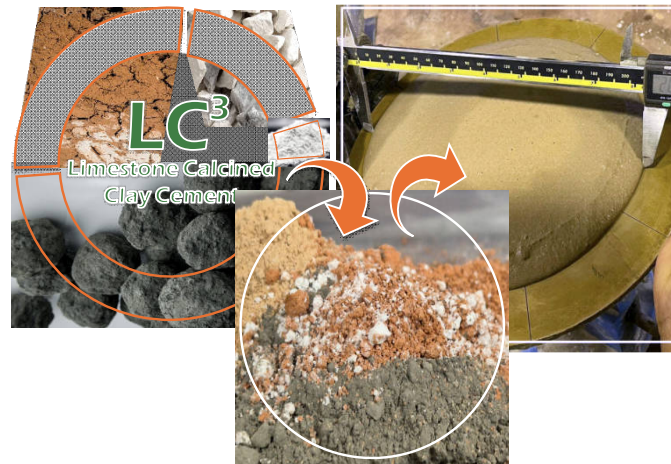
PI: Mr. Michael Rezaei





4.5. Development of Limestone Calcined Clay Cement (LC3) with Australian Montmorillonite Clay

Dr Jason Jiang from Western Sydney University collaborates with Adelaide Holdings to assess the adoption of Australian-sourced montmorillonite clay to produce limestone calcined clay cement (LC3) and expand the sustainability of cementitious binders.



INTRODUCTION

The availability of existing supplementary cementitious materials (SCMs), such as fly ash and steel slag, is rapidly declining in Australia. Limestone calcined clay cement (LC3) has the potential to reduce the CO₂ footprint by 60% from the cement chemical process and by 40% from alternative fuels — offering a sustainable alternative to cements containing SCMs. However, metakaolin is the primary choice of calcined clay for producing LC3. Due to the scarcity of kaolin clay in Australia, montmorillonite clay has emerged as a suitable alternative.

METHODS

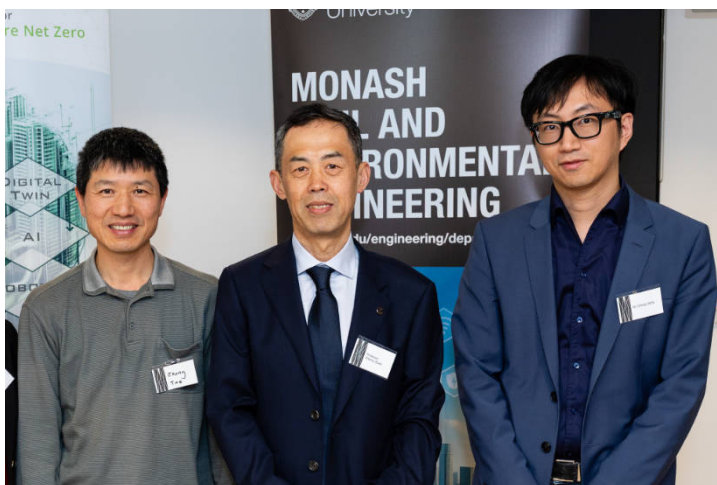
This project investigates the merits and limitations of adopting calcined montmorillonite clay in LC3 cementitious blends and the resulting concrete products.

OUTCOMES

Adopting calcined montmorillonite clay, in contrast to kaolin clay, in LC3 could offer greater economic benefits due to its abundance in Australia.

Preliminary results show that, compared to conventional metakaolin, calcined montmorillonite clay mitigates the adverse effects of the clay component on the fresh properties of concrete elements. They also show that LC3 concrete materials present enhanced compressive behaviour after high temperature exposures.

Challenges associated with LC3's workability and low early-age strength are under investigation.



TEAM

CI: Dr. Cheng (Jason) Jiang
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Prof. Zhong Tao

Dr. Reena Sanjay Krishna

PI: Mr. Johnson Liu



Adelaide Holdings

4.6. The Use of Oxide Composition in Ternary Blends to Design Low-Carbon Concrete

INTRODUCTION

The development and optimisation of new binders based on the partial substitution of cement with supplementary cementitious materials (SCMs) currently relies on empirical approaches – a process that’s both costly and time-consuming. Given that there’s a strong relationship between the oxide composition of the binder and the properties of the concrete, a database of properties based on this correlation would greatly enhance the process of binder optimisation.

With the help of AI, the project will enable the use of the ternary oxides of the binder to design a low-carbon concrete that meets performance-based specifications.

METHODS

1. Collate materials performance data published in the literature.
2. Experimentally determine the performance of blended cements.
3. Carry out durability studies on concretes (evaluate long-term performance).
4. Incorporate collated data from the literature and the experimental investigation into a machine learning program.

OUTCOMES

The project will ultimately yield a tool to predict performance based on oxide content, phase mineralogy and component physical properties.

Team from UTS led by Prof Vute Sirivivatnanon and Dr Paul Thomas works with HBM Group associations to develop AI-driven models for optimising cement binders incorporating supplementary cementitious materials (SCMs), enabling concrete manufacturers to reduce environmental impacts.



TEAM

CI: Prof. Vute Sirivivatnanon
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Dr. Paul Thomas;

PI: Mr. Craig Heidrich





4.7. Sustainable Materials for Construction

Prof Dong Ruan from the Swinburne University of Technology works with Contegrity to develop sustainable construction materials, such as roofs made from geopolymer binder instead of Portland cement or fired clay. These products feature lower embodied CO₂ and early/long-term strength.



INTRODUCTION

As the construction industry evolves, the development, characterisation and implementation of sustainable materials will be essential in meeting the challenges of climate change and resource scarcity.

Ongoing research and innovation in this field will help to identify new materials that can enhance sustainability in construction, ultimately leading to more resilient and environmentally friendly industry practices.

METHODS

Based on the literature review and Contegrity's needs, construction materials using either natural or recycled materials will be developed to support operational outcomes.

Mechanical tests including compressive, bending and durability tests will be conducted to explore the load-carrying capacities of the sustainable materials developed. Microstructural analyses will also be carried out to examine the deformation mechanisms.

Finite element (FE) models will be developed using experimental results. The valid FE models will subsequently be employed to conduct parametric studies.

OUTCOMES

Empirical/theoretical formulas will be proposed to reveal the relationship between performance indicators and influential factors. Such formulas can be used in engineering practice.



TEAM

CI: Prof. Dong Ruan
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Ms. Olivia Jingyu Wang

Ms. Shirley Xian Chen

PI: Mr. Kenan Feng





4.8. Balancing Fire Safety With Net Zero

INTRODUCTION

Lithium-ion energy storage is a leading technology for sustainable, emissions-free energy. The ability to store renewable energy, such as solar or wind, during off-peak hours and utilise it during peak-demand periods is becoming increasingly popular as governments worldwide shift towards renewable energy sources.

While lithium-ion (Li-ion) technology is generally considered safe and is continually improving, issues such as thermal runaway can occur when a short circuit causes a rapid release of thermal and electrochemical energy.

METHODS

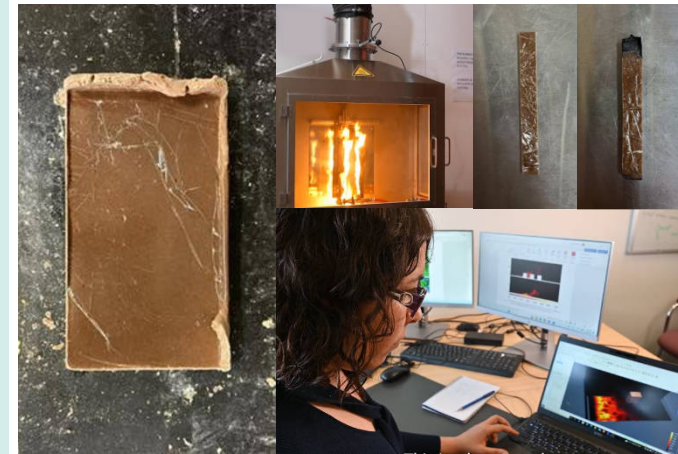
Development of a novel formulation of clay and polymer hybrid as thermal insulation boards to prevent Li-ion batteries thermal runaway (a process that includes the preparation of a gel dispersion paste and advanced insulation material).

OUTCOMES

The project aims to more effectively mitigate the risk of thermal runaway than current alternatives. This investigation isn't merely a reiteration of existing safety measures, but rather a transformative approach to battery safety that could redefine industry standards.

The team's efforts to develop application-specific materials will enhance safety, as well as streamline commercialisation pathways – encouraging wider adoption of renewable energy.

Dr. Maryam Ghodrat (UNSW) is working with BesTech to develop clay-reinforced polymer gels as a mature, passive, and inherently safe approach to thermal runaway mitigation in battery systems. These materials support both fire safety and net zero goals via performance optimization.

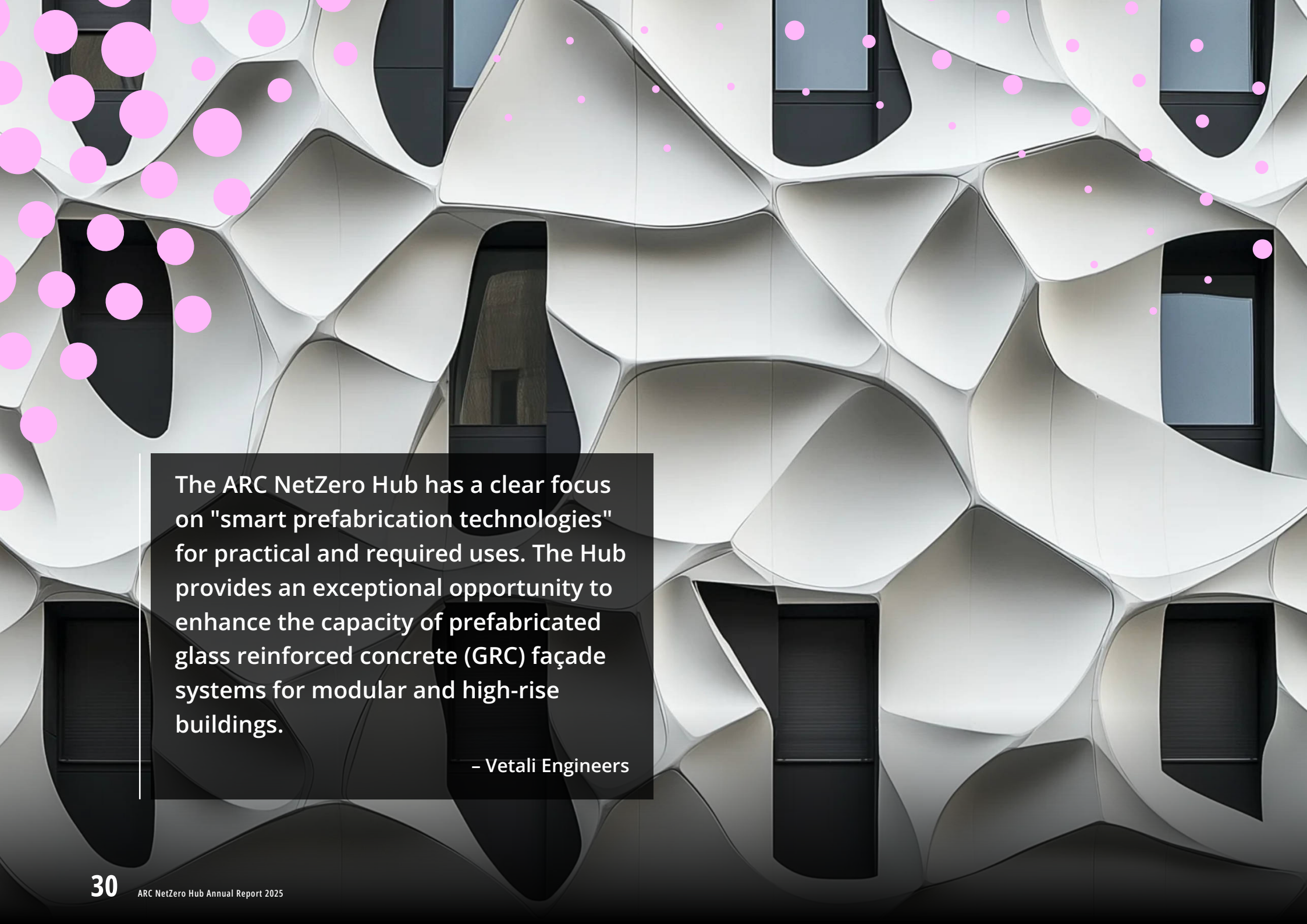


TEAM

CI: Dr. Maryam Ghodrat
(m.ghodrat@unsw.edu.au)

PI: Mr. Aniruddha Chakraborty





The ARC NetZero Hub has a clear focus on "smart prefabrication technologies" for practical and required uses. The Hub provides an exceptional opportunity to enhance the capacity of prefabricated glass reinforced concrete (GRC) façade systems for modular and high-rise buildings.

– Vetali Engineers

05 CONSTRUCTION

5.1. Overview

This theme aims to develop novel and empirically-supported strategies, tools and workflows to achieve net-zero emissions in the construction industry. With a focus on the various phases of construction, this theme comprises four research programs:

- **Program 1:** Digital engineering and sustainable building practices
- **Program 2:** Digital twins (DT) for sustainable construction
- **Program 3:** Circularity in modular construction: a case study of sustainable façade systems
- **Program 4:** AI-based supply chain optimisation for net-zero construction

Intended outcomes: a framework for transition to digitalisation and highly efficient and sustainable building practices; the creation of advanced DT platforms to facilitate smarter and more sustainable construction decision-making; a circularity evaluation system; AI-driven tools and systems to improve efficiency and lower costs.



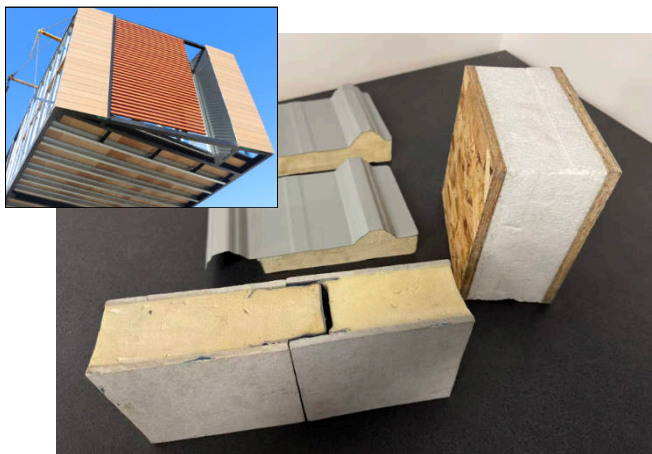
Hub-sponsored workshop on advances in 3D concrete printing at Swinburne University of Technology, co-organised by Hub CI Prof Pat Rajeev. The workshop featured participation from Hub CIs and HDR students (top image) and included a guided tour of Swinburne's Digital Construction Lab (bottom image).





5.2. High-Performance Building System Design

Prof Dong Ruan (Swinburne University of Technology) collaborates with iBuild to assess the application of passive building systems in modular construction as a high-performance envelope solution suitable for factory manufacturing and rapid on-site installation.



INTRODUCTION

The increasing demand for energy-efficient buildings has driven a greater need for innovative modular and prefabricated systems that can conserve, store and generate energy.

This project will focus on integrating passive building systems (PBS) technology with modular building systems and prefabricated glass-fibre reinforced concrete (GRC).

Additionally, the project will use building information modelling (BIM) and a conceptual smart building management system (BMS) to optimise design and energy performance.

METHODS

1. Use BIM to simulate and optimise the design and energy performance of modular building systems, focusing on main building parts such as roof, wall and window components.
2. Conduct theoretical analysis of GRC materials to assess their insulation, durability and recyclability.
3. Perform energy simulations to evaluate the effectiveness of integrating PV technology with prefabricated roof and wall systems, as well as the use of solar glass for modular windows.

OUTCOMES

This project will translate passive design principles and evidence from advanced wall and roof assembly research into practical physical prototypes. It aims to provide high-performance envelope solutions suitable for factory manufacturing and rapid on-site installation.



TEAM

CI: Prof. Dong Ruan (druan@swin.edu.au)

Mr. Laian (Andy) Luan

Mr. Jiabin (Bill) Lu

PI: Mr. Michael Zeng



5.3. Sustainable Façade System for Improved Thermal Performance

INTRODUCTION

Reducing the overall mass and orientation of major façade and roof surfaces is key to achieving the sustainability of building façades. Notably, glass-fibre reinforced concrete (GRC) cladding panels have emerged as a pivotal element, with the capacity to accommodate complex geometries while incorporating essential material properties (e.g. UV and impact resistance). However, key properties of GRC, such as workability, fire resistance and mechanical performance, remain poorly understood. This project evaluates how integrating low-carbon waste materials into GRC could enhance both its performance and manufacturability.

METHODS

1. Assess the structural integrity, durability and baseline performance of GRC façade materials.
2. Develop GRC mixes for easier fabrication.
3. Incorporate sustainable, low-carbon additives and polymers to enhance fire resistance.
4. Optimise GRC formulations for automation processes such as 3D concrete printing.
5. Conduct fire performance evaluations.

OUTCOMES

The aim is to develop low-carbon GRC mixes with enhanced thermal and fire performance and to create 3D-printable façade cladding for efficient manufacturing, advancing innovative material for greener, safer building construction.

Through experimental testing from material to structural scale, Prof Pat Rajeev (Swinburne University of Technology) collaborates with Vetali Engineers to leverage low-carbon materials to develop GRC façade elements with enhanced fire resistance and sustainability.



Flame on the specimen



TEAM

CI: Prof. Pat Rajeev
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PI: Mr. Sanjayan Siva

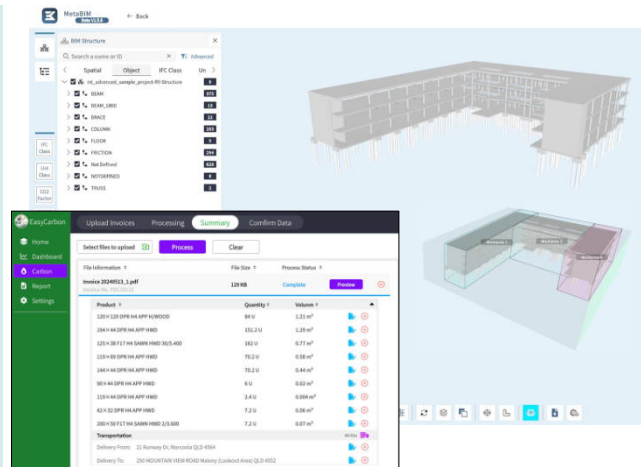


VETALI ENGINEERS



5.4. Prototype Digital Twin and AI-Driven Carbon Accounting Platform for Built Assets

Prof Peng Wu (Curtin University) and Dr Jun Wang (Western Sydney University) collaborate with the Sunshine Coast Council to create AI models that can track carbon emissions from construction invoices, ensuring efficient carbon accounting throughout the construction lifecycle.



INTRODUCTION

Many companies have set ambitious sustainability and net-zero targets. Granular carbon accounting helps to track progress in meeting these goals, identifying key areas for improvement, and implementing effective carbon-reduction strategies.

Digital modelling technologies (e.g. building information modelling (BIM), lifecycle assessment software, digital twins, cloud-based platforms, Internet of Things (IoT), artificial intelligence and machine learning) play a crucial role in achieving precise carbon accounting. These technologies enable detailed analysis, real-time monitoring and optimisation of carbon emissions, helping industries move towards a more sustainable future.

METHODS

The extracted data from an AI system will be integrated into a BIM module to estimate actual carbon emissions during the construction stage. This will enable the generation of detailed and accurate carbon accounting reports with comparisons between actual and planned carbon emissions, identification of discrepancies and their sources, and recommendations for reducing carbon emissions based on the findings.

OUTCOMES

The developed system will produce a variety of customised carbon-accounting reports tailored to different levels and stakeholders, such as project managers, environmental auditors, clients and regulatory bodies. These reports will help planners evaluate and deliver sustainable projects.



TEAM

CI: Prof. Peng Wu (peng.wu@curtin.edu.au),

Dr. Jun Wang

PI: Mr. Victor Mantilla





Expectations are high that the hub will dramatically contribute to transforming the Australian transport infrastructure industry through development of high-performance products and reducing energy inputs into operations and maintenance. In turn, this enhances the industry's global competitiveness, profitability and environmental performance.

- National Transport Research Organisation

06

OPERATION & MAINTENANCE

6.1. Overview

This theme aims to develop AI-powered operation and maintenance strategies for critical infrastructure. Intelligent sensor and AI technologies will be utilised in buildings and infrastructure health monitoring during the asset management phase – these will determine optimum maintenance strategies to limit the need for new construction. The theme consists of three research programs:

- **Program 1:** Digital twin for urban traffic operations and infrastructure maintenance
- **Program 2:** Pavement sustainability assessment for next-generation heavy freight vehicles
- **Program 3:** Intelligent monitoring technologies (IMT)

for infrastructure lifecycle management

Intended outcomes: optimisation of urban traffic operations and enhanced sustainability in pavement maintenance practice by leveraging

AI, digital twin and deep learning techniques; investigation of the impact of increased freight vehicle load on pavement sustainability; implementation of IMT for large-scale civil infrastructure service life assessment.

Hub HDR students attend NTRO International Technical Conference 2025, where Richard Yeo, Chief Operating Officer at the NTRO, warmly welcomed them. The Hub team had a chance to engage with global experts and explore innovations in transportation research and development.





6.2. ALF 1 Transverse Profiler

INTRODUCTION

Manual pavement inspections often display limited accuracy and inefficient data collection. Previous autonomous approaches improved repeatability, but remained constrained by environmental factors and discrete depth sampling, capturing only partial information. This project is developing an RGB-D camera-integrated linear rail system capable of continuously capturing both depth and surface texture data.

The system enables high-fidelity mapping with sub-2 mm precision, while reducing the total scanning time to under two minutes (10 m section). This capability allows for rapid, repeatable and data-rich surface assessments.

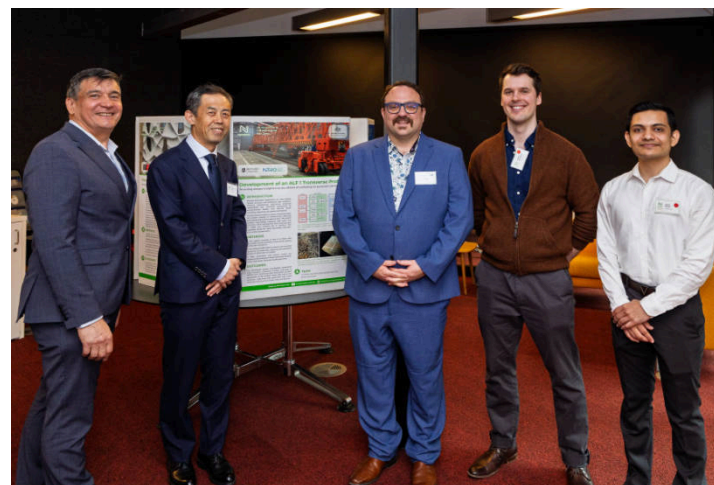
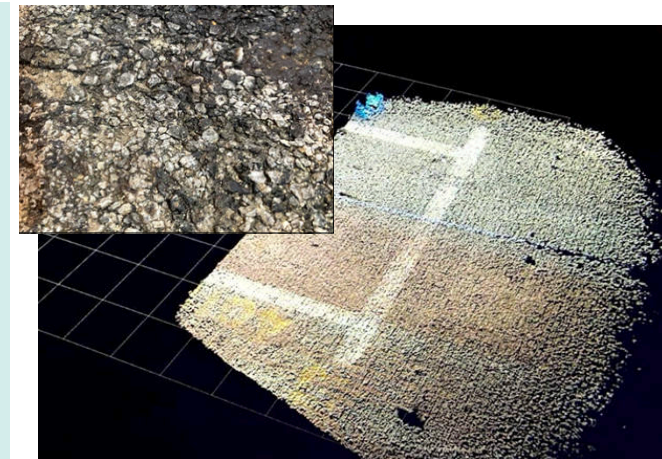
METHODS

1. The system consists of two 6 m linear rails mounted in series on NTRO's Accelerated Loading Facility (ALF) platform.
2. DS87 RGB-D cameras are mounted along the rail assembly, capturing the pavement surface in both colour and depth.
3. Data acquisition and motion control are implemented using the Robot Operating System, with a high-detail retention SLAM algorithm.

OUTCOMES

The system can successfully automate high-resolution pavement surface scanning at NTRO's ALF. Continuous data acquisition enables generation of 3D surface maps with sub-2 mm accuracy, capturing both geometric and visual characteristics such as cracks, wear and texture.

A/Prof Chao Chen (Monash University), in collaboration with NTRO, is developing a profiler solution for continuous pavement scanning. The system is designed to deliver greater robustness under varying environmental conditions and reduced cycle times compared with previous autonomous approaches.



TEAM

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Dr. Dariusz Skoraczynski

Mr. Ayham Ahmed

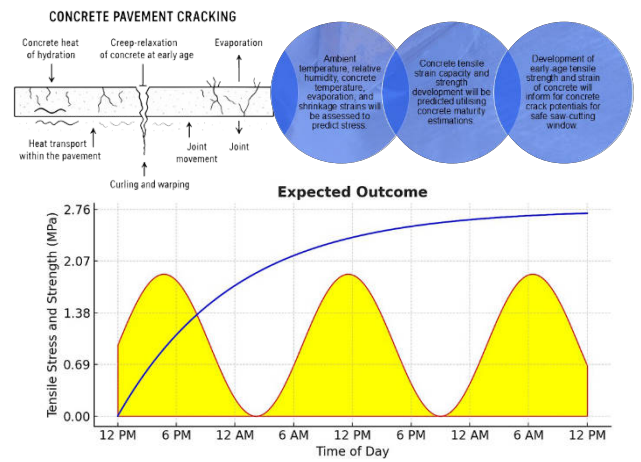
PI: Mr. Lance Laird





6.3. Predictive Model for Reliably Estimating Early Age Cracking Potential in Rigid Concrete Pavements

Prof Kirk Vessalas and Dr Aziz Mahmood (University of Technology Sydney) collaborate with TfNSW to compile a digital interface that offers a predictive model for quantitative concrete strength development and early-age stress, ensuring that the design life of rigid road pavements is achieved.



INTRODUCTION

The intended service life of rigid road pavement assets is significantly affected by early-age (1-3 days) concrete cracks from shrinkage, thermal differentials and weather conditions.

Currently, contractors carry out joint saw-cutting operations on concrete slabs to relieve these contractions. However, the current practice of saw-cutting is highly empirical.

To address this issue, this study aims to compile a digital interface that offers a predictive model for quantitative concrete properties and an early-age stress profile, enabling a safe saw-cutting procedure.

METHODS

The project uses data acquired in the lab and in the field to correlate and develop an accurate model for predicting the timeline for the occurrence of early-age cracking in concrete pavements.

This will supplement the works brief with critical information needed to ensure the sawing of joints is carried out in a timely manner to prevent the formation of unplanned cracks.

OUTCOMES

The project aims to develop mathematical models and, ultimately, a tool for estimating early-age cracking potential in rigid concrete pavements. This will help to introduce joints in order to prevent the formation of cracks, as well as to ensure that the estimated design life of 30 to 40 years for rigid road pavements is achieved.



TEAM
CI: Prof. Kirk Vessalas (Kirk.Vessalas@uts.edu.au)
 Dr. Aziz Mahmood
PI: Mr. Basil Ben (Lead)
 Dr. Ryan De Carteret
 Dr. Hossein Asadi



6.4. Connected Data and Agentic AI for Sustainable Infrastructure

INTRODUCTION

This project aims to develop an AI-powered decision support framework underpinned by TfNSW's Infrastructure Common Data Model (ICDM) and Engineering Cost and Carbon Library (ECCL). The framework will establish the ICDM as the foundation for consistent data exchange and connected data across the asset lifecycle. Further, it will integrate agentic AI to automate and optimise infrastructure decisions with a balance of cost, carbon and risk. It will also demonstrate the broader applicability of ICDM in asset management and digital engineering, thereby contributing to TfNSW's Sustainable Infrastructure Program and net-zero objectives.

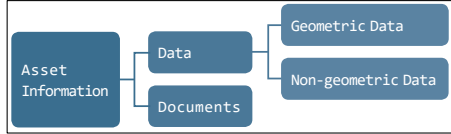
METHODS

1. Validate the ICDM as the foundation for consistent data exchange and integrated data connectivity across the entire asset lifecycle.
2. Develop and apply agentic AI algorithms that utilise ICDM and ECCL to automate key infrastructure decisions.
3. Demonstrate the applicability of ICDM beyond cost-carbon optimisation, showcasing its value for other aspects of asset management.

OUTCOMES

The proposed research aims to close the gap between structured infrastructure data and intelligent, automated decision-making. This will support the NSW Government's decarbonisation strategy and enable measurable progress toward net zero.

Prof Peng Wu (Curtin University) and Dr Jun Wang (Western Sydney University), along with TfNSW, are leveraging an Infrastructure Common Data Model and Engineering Cost and Carbon Library to create an AI-based framework for infrastructure asset maintenance.



Function	Group	Document	Document	Document	Document Combine	Data Item	Data Item Category	Rank	Sophistication Level	Design Team	Construction Team	Hand Over	MRIA	Armedialerd Dual
FUNCTION	GROUP					PURPOSE			SOPH					
Inventory	VehicleCrossings	8.3	32	1	8.3.32.1	D	2	1					Y	
Inventory	VehicleCrossings	8.3	32	2	8.3.32.2	D	2	1					Y	
Inventory	VehicleCrossings	8.3	32	3	8.3.32.3	D	2	2					Y	
Inventory	VehicleCrossings	8.3	32	4	8.3.32.4	D	2	2					Y	
Inventory	VehicleCrossings	8.3	32	5	8.3.32.5	D	2	2					Y	
Inventory	VehicleCrossings	8.3	32	6	8.3.32.6	D	2	3					Y	



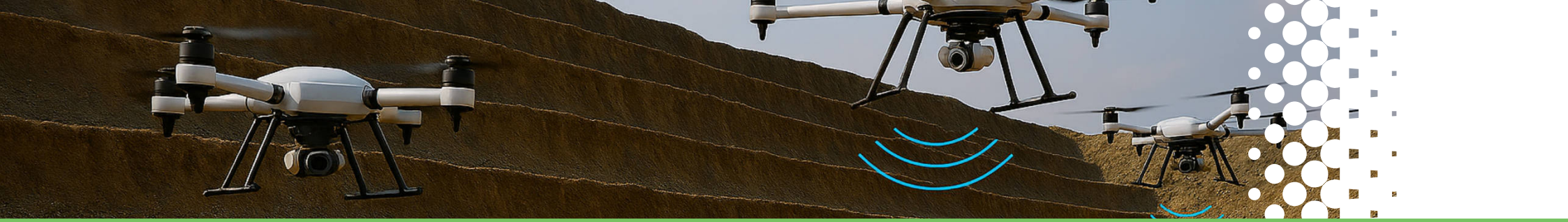
TEAM

CI: Prof. Peng Wu (peng.wu@curtin.edu.au)

Dr. Jun Wang

PI: Mr. David Kelly





6.5. Development of Robotic Survey and Navigation System in Mining Site

A/Prof Chao Chen's team at Monash University collaborates with Orica to leverage drone and robotic technology to develop autonomous vision systems capable of detecting features and reporting their locations on mining benches, reducing labour-intensive survey processes.



TEAM

CI: A/Prof. Chao Chen (chao.chen@monash.edu)

Dr. Dariusz Skoraczynski

Mr. Don Ranasinghe

PI: Mr. Cu Luu



INTRODUCTION

This research focuses on developing a fully automated robotic system for mining field surveys, utilising advanced robotics and autonomous vehicles to improve data collection accuracy. By integrating robotic systems for survey tasks, the system aims to reduce labor demands and enhance productivity. Additionally, a 3D mapping system will be developed to provide accurate and detailed data for improved decision-making and operational planning. This approach combines automation, robotics and advanced mapping technologies to modernise mining survey operations, ensuring sustainability and operational efficiency.

METHODS

1. Simultaneous Localisation and Mapping (SLAM): This enables real-time mapping and localisation of the mining site.
2. Path-planning algorithms: These are used for dynamic route calculation and obstacle avoidance.
3. Sensor fusion: This combines data from multiple sensors to provide precise localisation and enable obstacle detection.
4. Real-time communication: This facilitates seamless coordination between the robotic system and a central control hub.

OUTCOMES

The project will develop autonomous robotic and 3D mapping systems to conduct surveys on mining sites. A whole prototype system will be established and demonstrated in field.



Australia's journey to net zero emissions has taken a significant step forward with the official launch of the ARC Research Hub for Infrastructure Net Zero at Monash University. This initiative is set to revolutionise the construction sector, driving innovation, sustainability and economic strength across the nation.

- Australian Research Council

07 HUB LAUNCH

7.1. Official Hub Launch

On the 17 November 2025, we celebrated the official launch of the ARC NetZero Hub, marking an important milestone for the Hub and its partner organisations.

VIP guests included Prof Alison Ross, Academic Director, Humanities and Creative Arts at the ARC, along with Monash University's Dr Matthew French, representing the Deputy Vice-Chancellor (Research and Enterprise), Prof Yiannis Ventikos, Dean of Engineering, and Prof Ha Bui, Head of the Department of Civil and Environmental Engineering.

At the launch ceremony, Hub Director Prof Wenhui Duan outlined the vision behind the new research centre. He highlighted the NetZero Hub's potential to support large-scale deployment of digitalisation technologies across the infrastructure lifecycle, and to contribute to global efforts to reduce carbon emissions. He also expressed his appreciation for the ARC's support in advancing this research front.

Addressing ARC representatives, faculty colleagues and industry partners, Dr French

noted the Hub's role in developing practical and impactful net-zero solutions. Prof Ross followed with remarks recognising the significance of the NetZero Hub and the contributions of Prof Duan and his team. The ceremony concluded with a ribbon-cutting, inaugurating the ARC NetZero Hub.

We thank everyone involved in reaching this milestone. The launch represents a significant step in advancing research that aims to deliver practical, scalable pathways towards net zero.

Prof Ha Bui, Prof Yiannis Ventikos, Dr Matthew French, Prof Alison Ross and Prof Wenhui Duan (left to right) officially launch the ARC NetZero Hub.



7.2. Innovation in Action

Before the official Hub launch ceremony, a tour of the Monash Department of Civil and Environmental Engineering's Visualisation Laboratory took place. This featured research presentations from Hub Chief Investigators and Partner Investigators to showcase to government and university representatives how long-term research partnerships translate into real-world impact.

On the tour, these representatives saw three exciting Hub projects now coming to life. Dr Richard Yeo, Chief Operating Officer at NTRO, showcased the decade-long partnership that has delivered robotics-based pavement profiling technology that's now being rolled out nationally. Mr Michael Zeng, Director of iBuild Building Solutions, presented their portable, low-carbon housing solution designed to tackle Australia's housing crisis while slashing embodied emissions. Dr Yihai demonstrated digital-twin and AI-driven vehicle impact simulations that will help design infrastructure that dramatically reduces road fatalities. Together, these presentations exemplified the Hub's ability to turn cutting-edge research into scalable solutions of national significance.

Hub CI Dr Yihai Fang leads tour at the Monash Department of Civil and Environmental Engineering's Visualisation Laboratory.



Dr Richard Yeo, Chief Operating Officer at NTRO (left), and Mr Michael Zeng, Director of iBuild, showcase how research translates into real-world impact.

Government and university representatives tour Visualization Laboratory.





Sarah Klein (Australian marathoner), Prof Stephen Foster (UNSW), Prof Malek Bouazza (Monash University), Prof Nasser Khalili (UNSW), Prof Dikai Liu (UTS), Prof Paul Wood (ASTE), Prof Jayantha Kodikara (Monash University), Prof Ha Bui (Monash University), Prof Guillermo Narsilio (University of Melbourne), Prof Quek Ser Tong (National University of Singapore), Prof Yinghui Tian (University of Melbourne) and Prof Vivian WY Tam (Western Sydney University) (from top-left) deliver keynote speeches at the Grand Challenges in Infrastructure Workshop.

7.3. Keynotes

The Hub launch's Grand Challenges in Infrastructure Workshop brought together national and international leaders to explore pressing challenges, emerging technologies and collaborative pathways toward resilient, intelligent and net-zero infrastructure.

The event opened with an inspiring guest address by Sarah Klein, the first Australian woman to compete in four World Championship marathons. She shared her marathon story, highlighting the role of perseverance and long-term vision.

Other keynote speakers addressed strategic and technical challenges across infrastructure systems. Prof Stephen Foster, Emeritus Professor of Structural Engineering at the University of New South Wales, spoke about grand challenges in infrastructure. Next Prof Nasser Khalili, Head of the School of Civil and Environmental Engineering at the University of New South Wales, gave a talk on resilient and intelligent infrastructure systems.

Geotechnical, sustainable and digital innovation themes were explored by Prof Malek Bouazza (Monash University), Prof Jayantha Kodikara (Monash University), Prof Ha Bui (Monash University), Prof Guillermo Narsilio (University of Melbourne), Prof Yinghui Tian (University of Melbourne), Prof Quek Ser Tong (National University of Singapore), Prof Vivian WY Tam (Western Sydney University) and Prof Dikai Liu (University of Technology Sydney). They covered resilient systems, offshore development, cascading and complex disasters, sustainable construction and advanced infrastructure robotics.

The Hub extends a special thanks to Prof Paul Wood (Australian Academy of Technological Sciences & Engineering) for sharing his insights on research leadership and fellowship pathways.

7.4. Hub Project Showcases

The Grand Challenges in Infrastructure Workshop also featured a series of inspiring project showcases, highlighting early successes and the innovation emerging from ARC NetZero Hub projects.

In the field of geotechnical and construction materials, Prof Dilan Robert (RMIT University) presented deep learning approaches for image-based soil property prediction, while Dr Paul Thomas (University of Technology Sydney) discussed the use of ternary oxides in low-carbon concrete design. Prof Zhong Tao (Western Sydney University) showcased waste-based commercial products and Prof Pat Rajeev (Swinburne University of Technology) talked about sustainable façade systems for improved thermal performance.

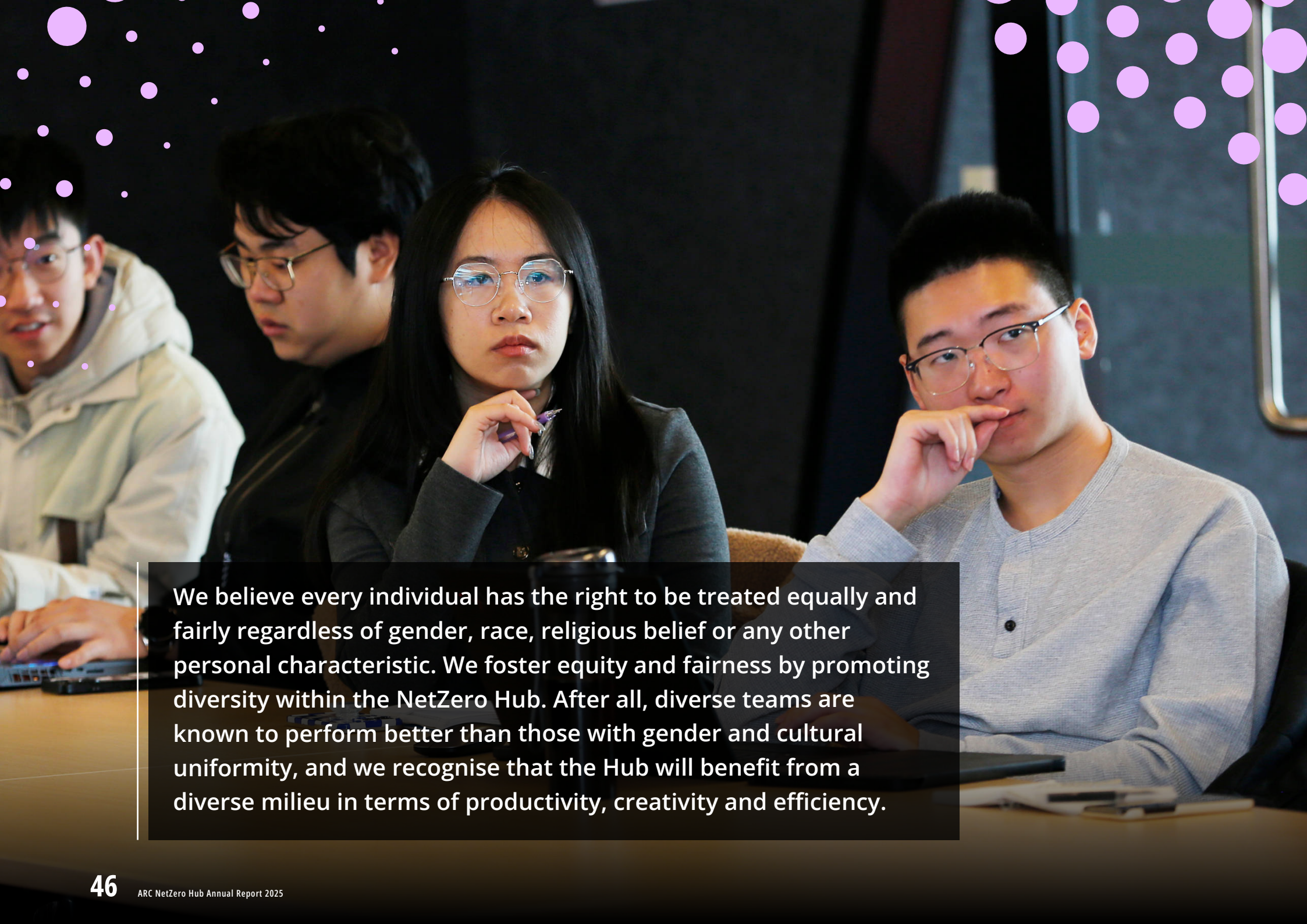
AI and robotics were also central themes across the showcases. Prof Lihai

Zhang (University of Melbourne) introduced an AI-powered digital-twin Enterprise Resource Planning (ERP) system for sustainable infrastructure, while Dr Yunlong Tang (Monash University) presented a service-oriented digital-twin framework for net-zero manufacturing. Building performance solutions were highlighted by Prof Peng Wu (Curtin University) who demonstrated building information modelling (BIM) and agentic AI for automated carbon estimation and tracking and A/Prof Chao Chen (Monash University) who showcased robotic innovations applied to infrastructure maintenance and mining.

Together, these project showcases reflected the Hub's strong momentum and offered a compelling glimpse of the impactful outcomes yet to come.



Prof Dilan Robert (RMIT University), A/Prof Chao Chen (Monash University), Dr Paul Thomas (University of Technology Sydney), Prof Lihai Zhang (University of Melbourne), Prof Zhong Tao (Western Sydney University), Dr Yunlong Tang (Monash University), Prof Pat Rajeev (Swinburne University of Technology) and Prof Peng Wu (Curtin University) (left to right) showcase early successes and innovation emerging from NetZero Hub projects.



We believe every individual has the right to be treated equally and fairly regardless of gender, race, religious belief or any other personal characteristic. We foster equity and fairness by promoting diversity within the NetZero Hub. After all, diverse teams are known to perform better than those with gender and cultural uniformity, and we recognise that the Hub will benefit from a diverse milieu in terms of productivity, creativity and efficiency.

08

CELEBRATING OUR PEOPLE AND MILESTONES

8.1. Overview

What an exciting start. In our first year, so much happened beyond the successful execution of agreements. We supported the placement of our first research fellows and Higher Degree by Research (HDR) students at partner organisations. We watched research begin to take shape in laboratories and in the field. And we welcomed visiting academics who shared their expertise with the Hub community.

The year also featured several important events and workshops organised and supported by Hub members, helping to strengthen connections between industry and academia. These included the Hub-sponsored Swinburne Workshop on 3D Concrete Printing, the Distinguished Workshops with Professor Caijun Shi, the Interdisciplinary Research Initiative for Human Habitats Future and the Grand Challenges in Infrastructure Workshop (detailed in Section 7).

In this section, we share a few snapshots of the people and moments that shaped our journey in 2025, and which will continue to inspire the Hub in the years ahead.

Dr Kwesi Sagoe-Crentsil, Mr Kunde Zhuang, Dr Karsten Mesecke, Mr Guohui Han, Mr Boyao Li, Dr Liao Huang, Dr Felipe Basquioto de Souza, Mr Irfan Hossain and NetZero Hub Director Prof Wenhui Duan (left to right) form the Hub team who ensured the success of events and workshops.





**Olivia Wang, Research Assistant,
Swinburne University of Technology**

8.2. Hub RA Lays Groundwork for Modular Buildings

With a background in building electrical engineering and intelligent systems, Olivia Wang comes well prepared for her current role as a research assistant under the supervision of Hub Chief Investigator Prof Dong Ruan at the Swinburne University of Technology. She is now part of a collaboration with Levi Pty Ltd to implement passive design in the development of high-performance modular buildings.

Olivia is exploring prefabricated structural insulated panels, photovoltaic technologies and advanced materials, such as glass fibre reinforced concrete, to create efficient, passive modular building solutions. She is also leveraging building information modelling (BIM) and smart building management systems to optimise building performance and to support net-zero energy goals. Olivia's valuable contribution will no doubt expedite innovations in sustainable construction.

Example of structural insulated panel (SIP) developed by Ms Olivia Wang, Prof Dong Ruan, and the Levi Pty Ltd team to enhance passive building systems (PBS) in modular construction.



8.3. Hub HDR Candidate Innovates AI Models to Support Geotechnical Practice

Graduate of the University of Moratuwa in Sri Lanka with an extensive background in soil-structure behaviour and computational modelling, Sachin Silva brings valuable expertise to his doctoral journey at RMIT University.

At the NetZero Hub, Sachin is supervised by the Hub Chief Investigator Professor Dilan Robert. Partnered with Intrax Consulting Group, Sachin is working to develop AI-based predictive models for soil behaviour. His research focuses on applying advanced machine learning and image recognition techniques to improve the understanding and prediction of soil behaviour. The project aims to deliver innovative tools to support geotechnical professionals in design and decision-making. Sachin's important work is expected to advance safer and more sustainable construction practices.



**Sachin Silva, HDR student,
RMIT University**



Mr Sachin Silva (left) delivers a poster presentation at the NetZero Hub official launch on how machine learning models can guide geotechnical professionals in design and decision-making.

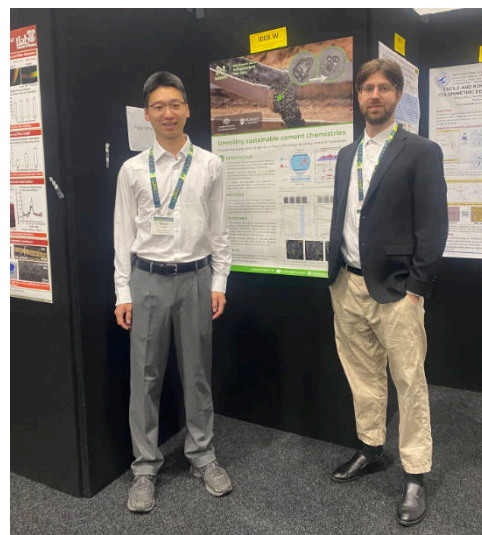


Boyao Li, Kunde Zhuang and Irfan Hossain (left to right), HDR Students at Monash University

8.4. Hub Students Present at MicroTAS Conference

In November 2025, HDR students Irfan Hossain, Boyao Li and Kunde Zhuang represented the Hub at the MicroTAS 2025 Conference in Adelaide. They engaged with leading researchers and presented their latest work on miniaturised experimental platforms for accelerating the optimisation of sustainable cementitious materials. Specifically, the students demonstrated how microfluidic technologies can provide new insights into the fundamental mechanisms governing cement hydration, at the same time creating opportunities to accelerate the screening and design of next-generation low-carbon cement. Their participation highlights the Hub's commitment to fostering emerging researchers and contributing innovative methodologies to the construction community.

Mr Boyao Li (left) and NetZero Hub Manager Dr Felipe Basquioto de Souza deliver a poster presentation on how microfluidics can be designed to investigate key stages of the hydration reaction of sustainable cements.



8.5. A/Prof Pang Sze Dai of NUS Visits Hub

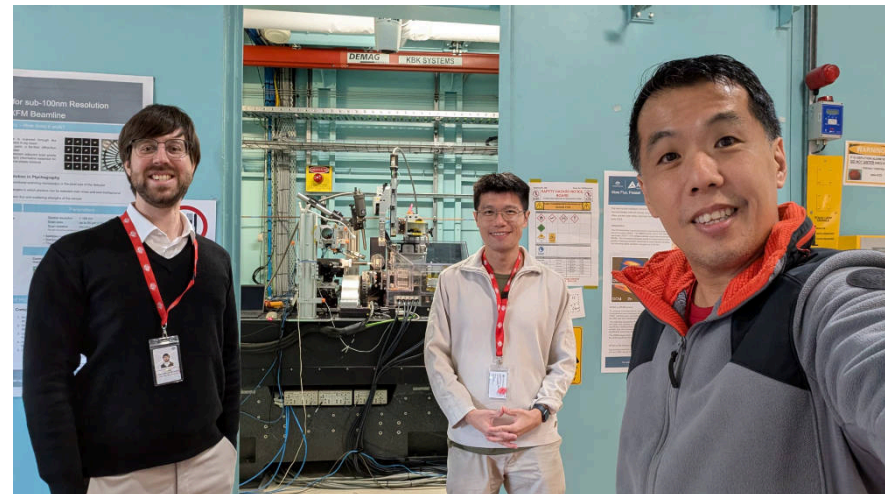
In July 2025, we were delighted to welcome A/Prof Pang Sze Dai from the Department of Civil & Environmental Engineering at the National University of Singapore for a research visit with our team. A/Prof Pang is internationally recognised for his work on sustainable construction materials and the application of advanced experimental and data-driven approaches to cementitious systems.

During his visit, A/Prof Pang collaborated closely with members of the NetZero Hub and engaged in a week of intensive experimental work at the Australian Synchrotron. The group focused on the application of synchrotron-based techniques for the advanced characterisation of cementitious and mineral-based materials. These interactions helped identify new avenues for joint research, particularly in the areas of data-driven materials development.



A/Prof Sze Dai Pang of the National University of Singapore (left) and NetZero Hub Director Prof Wenhui Duan

Collaborative experiments at the Australian Synchrotron give some of the Hub team their first experience with this facility. Dr Felipe Basquioto de Souza (Hub Manager), Dr Chi Sin Tang (research fellow at the Singapore Synchrotron Light Source) and A/Prof Sze Dai Pang (National University of Singapore) (left to right).





**Dr Karsten Mesecke, MPA Bremen,
Leibniz-Institut für Werkstofforientierte
Technologien - IWT**

8.6. Dr Mesecke Visits Hub and Enhances International Cooperation

Dr Karsten Mesecke (MPA Bremen, Leibniz-Institut für Werkstofforientierte Technologien - IWT) arrived in Australia in November 2025 for a six-month research collaboration with the Hub. Karsten is embedded in the research group of Prof Wenhui Duan at Monash University, where he is actively engaged in advanced, hands-on research.

His work focuses on the structure of calcium silicate hydrate (C-S-H), the key binding phase in concrete. By combining molecular dynamics simulations with total scattering analysis, Karsten aims to generate new insights that can enable improved modelling and, ultimately, more sustainable concrete design.

Dr Karsten Mesecke (right) collaborates with Dr Felipe Basquiroto de Souza at Monash University, fostering professional exchange on the sustainable transformation of the construction sector and creating momentum for future joint research initiatives in sustainable building.



8.7. Professor Paul Wood Facilitates Discussion on Research Impact on Society

On 17 November 2025, the Hub was honoured to organise a dinner event hosted by Professor Ha Bui, featuring guest speaker Professor Paul Wood AO FTSE, Board Director of the Australian Academy of Technological Sciences & Engineering (ATSE). Professor Wood delivered a presentation titled “Maximising ATSE’s Impact on Society”. Drawing on his extensive experience across academia and industry, he shared insights on translating research into societal impact and fostering innovation through strong collaboration between research institutions, industry and national organisations.

The event provided a valuable opportunity for networking and strategic discussion among participants, supporting the development of a shared vision for the future of civil infrastructure research in Australia.



Professor Paul Wood AO FTSE leads discussion on how science and engineering research can maximise its impact on society.



At a special dinner event during the NetZero Hub’s official launch, national leaders in civil infrastructure come together to discuss emerging challenges and opportunities in infrastructure research and to identify key priorities for the next 10 to 20 years.



Prof Caijun Shi, Chair Professor in the College of Civil Engineering at Hunan University

8.8. Prof Caijun Shi Hosts Two-Day Workshop

On 4–5 September 2025, the Hub had the honour of hosting Professor Caijun Shi, President of the Asian Concrete Federation and Chair Professor in the College of Civil Engineering at Hunan University. Prof Shi delivered a two-day workshop on high-performance concrete and carbonation of cementitious materials. The event provided valuable insights into durability and performance optimisation, as well as emerging approaches to low-carbon cement systems.

The workshop was a significant highlight for Hub students and early-career researchers, offering a chance to learn directly from a leading international expert in concrete materials. The visit also created valuable opportunities for discussion and knowledge exchange, helping to strengthen international collaboration and inspire new research directions within the Hub.

Hub students and early-career researchers, along with external industry and academic partners, take part in workshop led by Prof Caijun Shi (Hunan University), a leading international expert in concrete materials.



8.9. Hub Organises Interdisciplinary Research Initiative Workshop

The Interdisciplinary Research Initiative for Human Habitats Future Workshop brought together academics from leading Australian universities to explore emerging collaborative opportunities in sustainable infrastructure, construction technologies and the future of built environments. The workshop provided a platform for representatives from multiple ARC research hubs and training centres to present their initiatives and share perspectives on addressing major societal challenges related to energy transition, resilient infrastructure and sustainable construction systems.

The workshop fostered valuable dialogue on future collaboration and contributed to shaping a shared vision for the proposed ARC Centre of Excellence for Human Habitat Future, which aims to advance research and innovation for more sustainable and resilient human habitats.



Prof Wenhui Duan, NetZero Hub Director, at the Hub Interdisciplinary Research Initiative Workshop



With A/Prof Tim Peterson as MC, research initiative workshop brings together leading researchers from across Australia (including Prof Ha Bui, Prof Priyan Mendis, Dr Hossein Masoumi, Dr Kate Nguyen, Prof Tracy Ruan, A/Prof Lei Hou, Prof Tuan Ngo, Prof Xihong Zhang, Prof Jayantha Kodikara, A/Prof Rebecca Gravina, Prof Hong Guan, Prof Dominic Ong and Prof Wenhui Duan from institutions such as Monash University, University of Melbourne, RMIT University, Swinburne University of Technology, Curtin University, University of Queensland, Queensland University of Technology and Griffith University).



The official Hub launch brought together ARC representatives, faculty colleagues and industry partners, and highlighted the Hub's role in advancing impactful net-zero solutions.



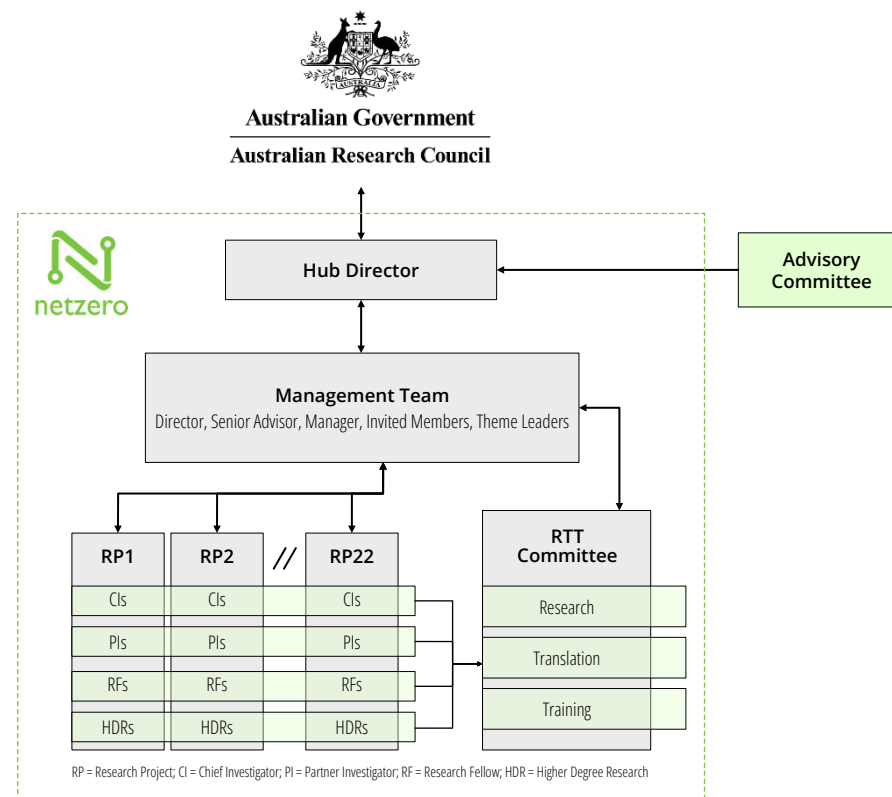
The Hub operates within a robust governance framework, led by the Director in consultation with the Management Team and Advisory Committee. The Management Team in turn works with the Research, Translation and Training Committee and Research Project Leaders. Together, they form an integrated and responsive network of academic and industry stakeholders.

09 GOVERNANCE

9.1. Overview

Strong governance underpins the Hub's performance, accountability and long-term impact. The Hub operates within a robust and clearly defined governance framework, led by the Director in consultation with the Management Team and the Advisory Committee, with the latter comprising independent academic and industry experts. The Management Team works closely with the Research, Translation and Training (RTT) Committee and Research Project (RP) Leaders, forming an integrated and responsive network of academic and industry stakeholders.

This structured and collaborative model ensures strategic oversight, transparent decision-making and operational excellence, while advancing the Hub's core pillars: Research Innovation & Translation, Professional Development, Gender Equality & Diversity and Outreach.



Schematic representation of the ARC NetZero Hub's organisational structure.

9.2. Management Team

The Management Team oversees the overall management and operations of the ARC NetZero Hub. It plays a central role in implementing and periodically reviewing the Hub Plan and Communications Plan, ensuring activities remain aligned with strategic objectives.

The Team advises the Hub Director on the development and stewardship of the Hub's research agenda, including monitoring progress against milestones, budgets, and intended research outcomes. It also considers emerging opportunities to strengthen impact and relevance.



Hub Director
Prof Wenhui Duan



Senior Hub Manager
Dr Kwesi Sagoe-Crentsil



Hub Manager
Dr Felipe B. de Souza



Dr Felipe Basquiroto de Souza (left) and Dr Kwesi Sagoe-Crentsil combine fresh innovation and seasoned expertise to deliver effective university and industry engagement platforms.

The Monash Research Office, with assistance from Dr Teresa Howard, Ms Vicky Koo, Ms Shoni Bruell and Ms Lyndall Sargent, as well as the Monash Finance team, with assistance from Ms Joanne Chen, supported the Hub Management Team in 2025 to ensure compliance and effective governance across all Hub activities.





Prof Yiu-Wing Mai (Chair)
The Hong Kong Polytechnic University



Prof Lihai Zhang
The University of Melbourne



Prof Ser Tong Quek
National University of Singapore



Prof John Carter
The University of Newcastle



Prof Vivian W. Y. Tam
Western Sydney University



Prof Stephen Foster
University of New South Wales



Prof Wenhui Duan
Monash University



Dr Kwesi Sagoe-Crentsil
Monash University



Dr Felipe B. de Souza
Monash University

9.3. Advisory Committee

The Advisory Committee provides high-level strategic guidance to the Hub Director to ensure the Hub's activities align with its objectives under the ARC Industrial Transformation Research Hubs scheme. It advises on advancing research, innovation and industry impact towards infrastructure net-zero goals. Additionally, the Committee advises the Hub Director on strategic directions and plans, establishment and management of the Hub's scientific and industrial impact agenda, and proposals for new activities and priorities.

First Hub Advisory Committee meeting brings together expert advisors Prof Stephen Foster, Prof Vivian WY Tam, Prof Lihai Zhang, Prof Ser Tong Quek, Prof John Carter and Prof Yiu-Wing Mai. Discussions focus on ensuring early strong progress, aligning future plans with other net-zero-related hubs, leveraging collaborative opportunities and identifying potential new programs.



9.4. Research, Translation, and Training (RTT) Committee

The Research, Translation and Training (RTT) Committee (which consolidates functions of the Research, Training & Education and Translation & Commercialisation Committees outlined in the Hub Proposal) is guided by the Hub leadership along with the Hub Key Chief Investigators (KCIs). The RTT Committee communicates and coordinates with four internal subgroups (CI, PI, RF and HDR student groups) to oversee the Hub's core pillars: Research Innovation & Translation, Professional Development, Gender Equality & Diversity and Outreach.

Established at the end of 2025, the RTT Committee is responsible for:

- overseeing the Hub's training goals (including promoting diversity), advising on fund allocation within Hub programs, and mitigating risks to uphold the relevance and integrity of research from both scientific and industry perspectives;
- guiding strategic industry trends, technological opportunities and potential commercial avenues;
- developing strategies for active engagement programs to ensure the market is prepared for the AI path to net zero;
- fostering collaboration among Hub members across different participant organisations and stakeholders, organising collaborative workshops, training sessions and pilot programs, and, ultimately, contributing to the development of a vibrant network of academic and industry stakeholders.



Prof Lihai Zhang (Chair)
The University of Melbourne



Prof Vute Sirivivatnanon
University of Technology Sydney



Prof Chao Chen
Monash University



Prof Pat Rajeev
Swinburne University of Technology



Prof Wenhui Duan
Monash University



Dr Kwesi Sagoe-Crentsil
Monash University



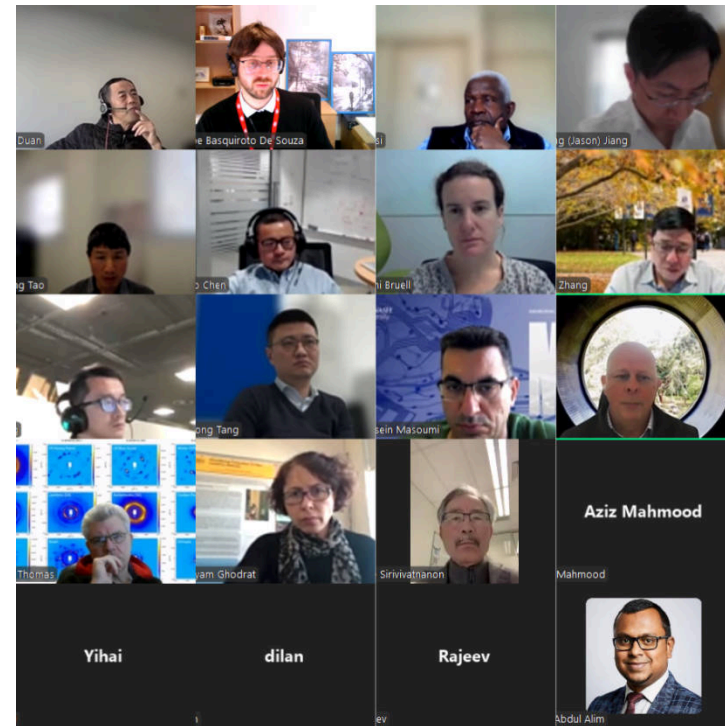
Dr Felipe B. de Souza
Monash University

9.5. Chief Investigators

Spanning eight universities across Australia, the ARC NetZero Hub brings together some of the nation's brightest minds in science and engineering.

Chief Investigators (CIs) lead or participate in one or more Hub projects, in partnership with industry collaborators at the forefront of innovation in construction technology. This ensures alignment between cutting-edge research and real-world application.

Hub CIs meet three times in 2025, both in person and online, to discuss key matters, such as overall Hub progress, compliance and documentation requirements, and KPI tracking and reporting. These meetings also provide an important forum to share research highlights, address emerging challenges and identify new collaboration opportunities across the network.



Chief Investigators



Prof Lihai Zhang
The University of Melbourne



Prof Dilan Robert
RMIT University



Prof Vute Sirivivatnanon
University of Technology Sydney



Prof Chao Chen
Monash University



Prof Dong Ruan
Swinburne University of Technology



Dr Maryam Ghodrat
University of New South Wales



Prof Pat Rajeev
Swinburne University of Technology



A/Prof Hossein Masoumi
Monash University



Prof Zhong Tao
Western Sydney University



Dr Yunlong Tang
Monash University



Prof Peng Wu
Curtin University



Dr Cheng Jiang
Western Sydney University



Dr Michelle Mak
Western Sydney University



A/Prof Kirk Vessalas
University of Technology Sydney



Dr Paul Thomas
University of Technology Sydney

Chief Investigators



Prof Hai Vu
Monash University



Prof Emad Gad
Swinburne University of Technology



Dr Aziz Mahmod
University of Technology Sydney



Dr Md Abdul Alim
Western Sydney University



Dr Jun Wang
Western Sydney University



Dr Yihai Fang
Monash University



Dr Thanh Nguyen
University of Technology Sydney

9.6. Partner Investigators

Each ARC NetZero Hub research project partners with an industry-based Partner Investigator (PI) to ensure our research outputs are business-ready and marketable.

The unique collaborative approach of the Hub structure is the key to our eventual success in advancing the infrastructure sector in Australia.



Two representatives from Agnico Eagle's Fosterville Mine in Victoria, including Hub PI Matthew Farrington (right), visit the Monash University Civil Engineering Laboratory to gain insight into research activities and explore new collaboration opportunities.



Mr Yifei Wang
AIBUILD



Mr Kenan Feng
Contegrity



Mr Michael Zeng
iBuild Building Solutions



Mr Nigel Guo
Intrax Consulting Group



Mr Craig Heidrich
ADAA, ASA, APoZA



Mr Maroun Rahme
Nu-Rock Technology



Mr Bob Xu
Knox City Council



Mr Richard Yeo
National Transport Research Organisation (NTR0)



Mr Aniruddha Chakraborty
Bestech Australia

Partner Investigators



Dr Hossein Asadi
Transport for New South Wales



Mr Basil Ben
Transport for New South Wales



Mr Luke Cremen
Transport for New South Wales



Mr Victor Mantilla
Sunshine Coast Council



Mr Cu Luu
Orica



Mr Matthew Farrington
Agnico Eagle



Mr Lance Laird
National Transport Research
Organisation (NTR)



Mr Li Xu
AUIIC (Vivistand)



Mr Sanjayan Sivasubramaniam
Vetali Engineers



Mr Shane Leary
DAS Mining Solutions



Mr Michael Rezaei
GeoSAS

Mr Jonathan Curry
Advanced Precast

Mr James Ni
Star Combo Australia

Mr Johnson Liu
Adelaide Holdings

9.7. Research Fellows, Research Assistants, HDR Students and Research Visitors

The ARC NetZero Hub draws on the knowledge, ideas and enthusiasm of early-career researchers and students to deliver hands-on research and accelerate the development of sustainable infrastructure technologies. In its first year, the Hub engaged seven research fellows, seven research assistants, twelve Higher Degree by Research (HDR) students as well as research visitors across a range of subprojects. These projects are closely connected with Partner Organisations, creating valuable opportunities for knowledge exchange, skills development and research translation throughout each project lifecycle.

Research Fellows



Dr Dariusz Skoraczynski
Monash University



Dr Boran Zhang
The University of Melbourne



Dr Hanwen Kang
Monash University



Dr Utsab Katwal
Western Sydney University



Dr Shao Liu
Monash University



Dr Shuangmin Shi
The University of Melbourne



Dr Reza Aghajanzadeh
Monash University

Research Assistants



Ms Olivia Jingyu Wang
Swinburne University of Technology



Mr Edric Lay
Monash University



Dr Liao Huang
Monash University

Ms Shirley Xian Chen
Swinburne University of Technology

Mr Laian (Andy) Luan
Swinburne University of Technology

Sri Shanka Sri Shantha
Monash University

Mr Jiabin (Bill) Lu
Swinburne University of Technology

HDR Students



Mr Sachintha Thejan
The University of Melbourne



Mr Sachin Silva
RMIT University



Mr Chunyu Jiang
Monash University



Ms Sandali
Western Sydney University



Mr Yizhen Ren
University of Technology Sydney



Mr Ayham Ahmed
Monash University



Mr Amir Mohamadi
Monash University



Mr Don Ranasinghe
Monash University



Mr Irfan Hossain
Monash University



Mr Boyao Li
Monash University



Mr Kunde Zhuang
Monash University



Mr Yang Liu
Western Sydney University

Research Visitors



Dr Karsten Mesecke
IWT Bremen / Monash University



Mr Guohui Han
Hohai University / Monash University



The official Hub launch featured special guest Sarah Klein (centre), the first Australian woman to compete in four World Championship marathons. She is pictured with two “marathoner professors”, Wenhui Duan (left) and Michael Kennedy.

10 PERFORMANCE

10.1. Overview

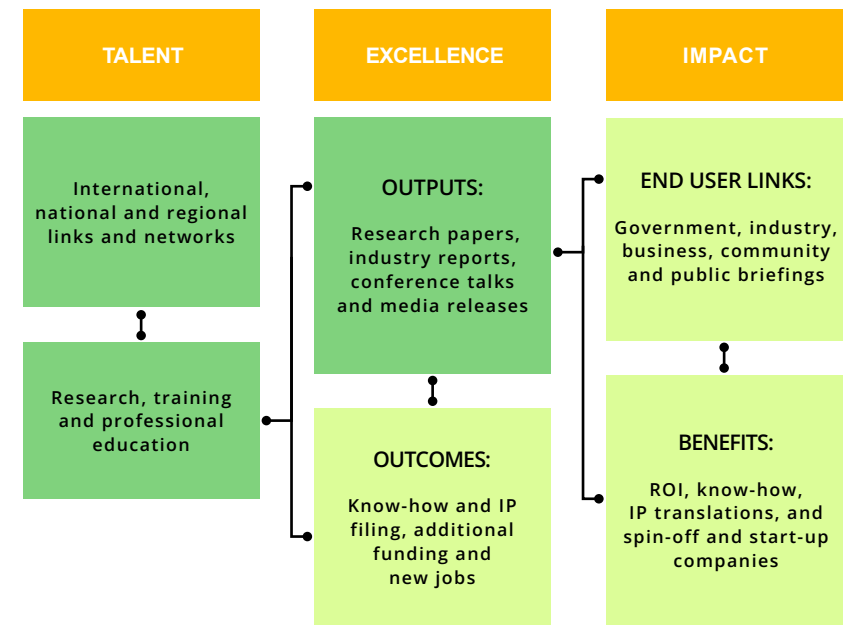
The Australian Research Council Industrial Transformation Research Hubs scheme has developed a key performance indicator (KPI) system to stimulate the translation of technological innovations from academia to industry. The system relies on seven KPI categories:

- traditional research outputs;
- non-traditional research outputs;
- visits to the project;
- public, government, industry and business community briefings
- commentaries about the project's achievements;
- additional funding secured;
- mentoring programs and placement of post-doctoral fellows and HDR students in Partner Organisations.

The Hub has adopted a three-phase approach to deliver high performance: talent, excellence

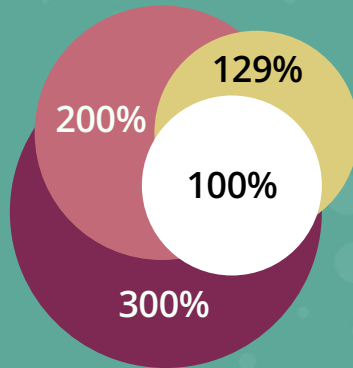
and impact. Research training and education, research links and networks, and outputs combine to bolster excellence in university research, whereas outcomes, end-user links and benefits support the commercialisation of innovations by industry. By catering to the needs of universities and industry, the KPI system maintains a balanced and mutually beneficial relationship between them.

Hub's three-phase approach to deliver high performance.



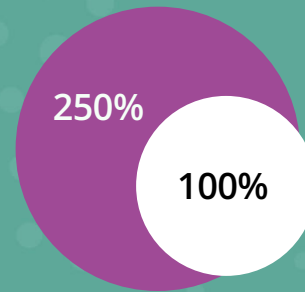
2025 Key Performance Indicators

RESEARCH OUTPUTS



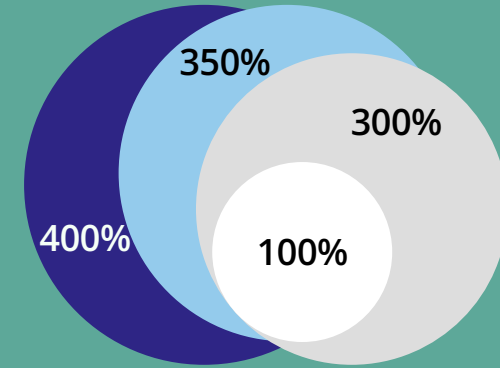
- KPI: 100%
- Journal articles
- Book chapters
- Conference publications

VISITS TO THE PROJECT (>1 WEEK)



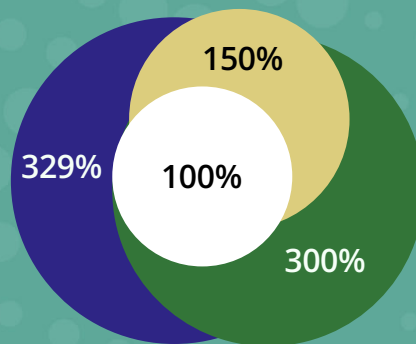
- KPI: 100%
- Academic visitors

PUBLIC, GOVERNMENT, INDUSTRY AND BUSINESS COMMUNITY BRIEFINGS



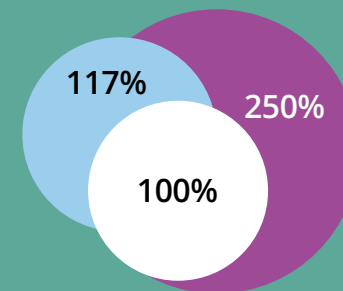
- KPI: 100%
- To public
- To government
- To industry/business/end users

COMMENTARIES ABOUT THE PROJECT'S ACHIEVEMENTS



- KPI: 100%
- Media releases
- Articles
- Social Media

NUMBER OF POST-DOCTORAL FELLOWS AND HDR STUDENTS



- KPI: 100%
- Number of post-doctoral fellows
- Number of HDR students

2025 Key Performance Indicators

RESEARCH OUTPUTS		
Project ID / CI	Title	Output type
IH24.01 / Prof Lihai Zhang	Structural reliability and resilience of building cladding subjected to hail impact	Conference publications
	Life cycle assessment of reinforced concrete panel considering multi-ion corrosion: A coupled chemical and electrochemical model	Conference publications
	Assessing the structural reliability of cladding panels under hail impact	Conference publications
	Predictive modelling of hail impact damage on toughened glazing panels (Book: Climate-Resilient Structures and Infrastructures)	Book chapters
	Performance modelling of aluminium building cladding under hail hazards (Book: Climate-Resilient Structures and Infrastructures)	Book chapters
IH24.04 / Prof Dilan Robert	Vision-based transformer applications in geotechnical engineering - a review and comparative study (Under Review)	Journal articles
IH24.07 / Dr Yunlong Tang	Bio-inspired perturbed hierarchical mechanical metamaterial for energy absorption (International Journal of Mechanical Sciences (2025): 110847)	Journal articles
IH24.08 / Prof Tao, Dr Mak, Dr Alim	Can calcined waste materials and low-grade clays be part of the limestone calcined clay cement binder system? An Australian case study (Journal of Materials in Civil Engineering 38.2 (2026): 05025013)	Journal articles
IH24.11 / Prof Pat Rajeev	Reassessing Fire Design Provisions for Concrete Structures Under Emerging Electric Vehicle Fire (Fire 9.1 (2025): 21)	Journal articles
IH24.12 / Dr Cheng Jiang	Enhancing desert sand concrete with fibre-reinforced polymer (FRP) confinement: Mechanical and microstructural perspectives (Sustainable Materials and Technologies 45 (2025): e01503)	Journal articles
	GUI-based hybrid ML model for predicting ultimate strength of FRP-confined UHPC with CTGAN-augmented data (Composite Structures (2025): 119905)	Journal articles
	Waste iron ore tailings (IOTs) in limestone calcined clay cement (LC3) composites (Construction and Building Materials 497 (2025): 143850.)	Journal articles
	Effect of strain rate on the stress–strain behavior of FRP–confined concrete cylinders: Review and model (Structures. Vol. 82. Elsevier, 2025.)	Journal articles
NetZero Hub / Prof Wenhui Duan	A critical review and perspectives on atomistic models of non-crystalline cementitious materials (Cement and Concrete Research 199 (2026): 108067)	Journal articles

2025 Key Performance Indicators

VISITS TO THE PROJECT (>1 WEEK)		
Project ID / CI	Academic Visitor	University / Institution
IH24.10 / Prof Chao Chen	Prof Jozsef Kovacs	McGill University
NetZero Hub / Prof Wenhui Duan	Mr Guohui Han	Hohai University
	Dr Karsten Mesecke	Institute for Materials Testing (MPA) - IWT Bremen
	Prof Sze Dai Pang	National University of Singapore
	Prof Caijun Shi	Hunan University

COMMENTARIES ABOUT THE PROJECT'S ACHIEVEMENTS		
Project ID / CI	Title	Commentary type
IH24.01 / Prof Lihai Zhang	Engineering management research contributes to the launch of ARC NetZero Hub	Media release
IH24.07 / Dr Yunlong Tang	Star Combo partners with Monash University to propel intelligent Australian advanced manufacturing initiative with government grant funding	Articles
	Monash x Star Combo - fast-tracking smart manufacturing	Media release
NetZero Hub / Prof Wenhui Duan	ARC NetZero Hub officially launched	Media release
Other	The Infrastructure Carbon Problem You're Building Right Now (Built-it.au)	Articles
	Revolutionising Australia's construction industry (Australia Research Council)	Articles

2025 Key Performance Indicators

PUBLIC, GOVERNMENT, INDUSTRY AND BUSINESS COMMUNITY BRIEFINGS		
Project ID / CI	Event / Location	Audience
IH24.01 / Prof Lihai Zhang	CI Keynote at the 4th Asia-Pacific International Conference on Additive Manufacturing - RMIT University	To public
	CI Presentation at Grand Challenges in Infrastructure Workshop - Monash University	To public
	CI Presentation at 1st International Conference on Infrastructural Monitoring and Protection - Perth, Australia	To public
	CI Presentation at APCOM-ACCM 2025 - Brisbane, Australia	To public
IH24.02 - Prof Dong Ruan	CI Presentation at Interdisciplinary Research Initiative for Human Habitats Future - Monash University	To public
IH24.03 - Prof Dong Ruan	PI Presentation at Hub Launch Laboratory Tour - Monash University	To government
IH24.04 / Prof Dilan Robert	CI Presentation at Grand Challenges in Infrastructure Workshop - Monash University	To public
	HDR Student Poster Presentation at Grand Challenges in Infrastructure Workshop - Monash University	To public
IH24.05 / Prof Vute, Dr Paul	CI Presentation at Grand Challenges in Infrastructure Workshop - Monash University	To public
IH24.07 / Dr Yunlong Tang	CI Presentation at ECR - AI for Engineering Workshop - Monash University	To industry/business/end users
	CI Presentation at Grand Challenges in Infrastructure Workshop - Monash University	To public
IH24.08 / Prof Tao, Dr Mak, Dr Alim	CI Presentation at Grand Challenges in Infrastructure Workshop - Monash University	To public
IH24.10 / Prof Chao Chen	CI Presentation at Grand Challenges in Infrastructure Workshop - Monash University	To public
	PI Presentation at Hub Launch Laboratory Tour - Monash University	To government
IH24.11 / Prof Pat Rajeev	CI Presentation at Grand Challenges in Infrastructure Workshop - Monash University	To public
	CI Keynote at Swinburne Workshop on 3D Concrete Printing - Swinburne University of Technology	To public
IH24.13 / Hossein Masoumi	CI Presentation to Agnico Eagle representatives at Civil Engineering Laboratory - Monash University	To industry/business/end users
	CI Presentation at Interdisciplinary Research Initiative for Human Habitats Future - Monash University	To public
IH24.18 / Prof Wu, Dr Wang	CI Presentation at Grand Challenges in Infrastructure workshop - Monash University	To public
NetZero Hub / Prof Wenhui Duan	Hub Manager Presentation at Swinburne Workshop on 3D Concrete Printing - Swinburne University of Technology	To industry/business/end users
	Hub Manager Poster Presentation at MicroTAS Conference - Adelaide, Australia	To public
	Hub Manager Presentation at ICASCM International Conference - Nanjing, China	To public
	Hub Manager Presentation to Undergraduate Students at UNESC University - Criciuma, Brazil	To public
	Hub Director Presentation at NTU-CEE Distinguished Seminar Series - Singapore	To public
	Hub Director Presentation at 5th Asian Concrete Federation Symposium - Singapore	To public
	Hub Director Presentation at ARC NetZero Hub Launch - Monash University	To government
	Hub Director Presentation at 19th Nanobiofluids Seminar - Kyoto University, Japan	To public
CI Dr Yihai Fang Presentation at Hub Launch Lab Tour - Monash University	To government	

2025 Key Performance Indicators

POST-DOCTORAL FELLOWS, RESEARCH ASSISTANTS, AND HDR STUDENTS PLACED IN PARTNER ORGANISATIONS		
Project ID / CI	Title / Name	Position
IH24.01 / Prof Lihai Zhang	Dr Shuangmin Shi	Postdoctoral Fellow
	Mr Sachintha Thejan	HDR Student
	Dr Boran Zhang	Postdoctoral Fellow
IH24.02 - Prof Dong Ruan	Ms Olivia Jingyu Wang	Research Assistant
	Ms Shirley Xian Chen	Research Assistant
IH24.03 - Prof Dong Ruan	Mr Laian (Andy) Luan	Research Assistant
	Mr Jiabin (Bill) Lu	Research Assistant
IH24.04 / Prof Dilan Robert	Mr Sachin Silva	HDR Student
IH24.06 / Prof Chao Chen	Mr Hanwen Kang	Postdoctoral Fellow
	Mr Chunyu Jiang	HDR Student
	Mr Edric Lay	Research Assistant
	Mr Shao Liu	Postdoctoral Fellow
IH24.07 / Dr Yunlong Tang	Sri Shanka Sri Shantha	Research Assistant
IH24.08 / Prof Tao, Dr Mak, Dr Alim	Dr Utsab Katwal	Postdoctoral Fellow
	Mr Yang Liu	HDR Student
	Mr Sandali	HDR Student
IH24.10 / Prof Chao Chen	Mr Ayham Ahmed	HDR Student
	Dr Dariusz Skoraczynski	Postdoctoral Fellow
IH24.13 / Hossein Masoumi	Mr Amir Mohamadi	HDR Student
	Dr Mohammadreza Aghajanzadeh	Postdoctoral Fellow
	Mr Goran Shirzad	HDR Student
IH24.20 / Prof Chao Chen	Dr Dariusz Skoraczynski	Postdoctoral Fellow
	Don Ranasinghe	HDR Student
NetZero Hub / Prof Wenhui Duan	Mr Mohammad Irfan Hossain	HDR Student
	Mr Boyao Li	HDR Student
	Mr Kunde Zhuang	HDR Student
	Dr Liao Huang	Research Assistant

2025 Key Performance Indicators

HUB FINANCE		
Reporting Period	2025	
Income	Cash (\$)	In-Kind (\$)
ARC	1,122,200.00	–
Industry Partners	863,275.00	970,658.00
Universities	144,788.00	541,220.24
Total	2,130,263.00	1,511,878.24
Expenditure	Cash (\$)	In-Kind (\$)
ARC	531,012.00	–
Industry Partners	271,771.93	–
Universities	87,961.63	–
Total	890,745.56	–



ARC Research Hub for
Infrastructure
Net Zero

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<https://www.monash.edu/arc-netzero>



Australian Government
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