CENTRE FOR INFRASTRUCTURE ENGINEERING

Capability Statement

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ABOUT THE CENTRE

Originally formed as the Institute for Infrastructure Engineering on January 1st, 2012 and built out of the work of the Civionics Research Centre, the Centre for Infrastructure Engineering (CIE) has grown into a leading centre of academic excellence and a forerunner in engineering research. With highly experienced academics in the fields of civil, structural and mechanical engineering, and a robust cohort of high-achieving students seeking to undertake research within the centre, CIE has been involved in a range of research collaborations and projects aimed at solving current challenges in today's infrastructure needs.

The centre currently operates with the expertise of 24 permanent academics and post-doctoral fellows, and over 50 doctoral candidates undertaking the centre's various research projects. CIE also boasts a number of visiting academics and researchers, all of whom are able to consult on highly specialised engineering projects and requests, and who also give expert assessment of products, procedures and design criteria in construction and civil works. Facilitated by the WSU Innovation and Consulting Unit, CIE experts deliver their knowledge to corporate, government and community clients from across Australia and beyond.

OUR MISSION:

The Centre for Infrastructure Engineering aims to develop innovative solutions that address the effective design and maintenance of civil infrastructure. A network of efficient and well-maintained infrastructure is crucial to the growth and prosperity of Australia.

The Centre for Infrastructure Engineering focuses its research efforts in the following areas:

→ Materials

→ Structures

→ Sustainability

The Centre for Infrastructure Engineering continues to build on these research strengths by establishing strategic research partnerships, as well as collaborating with researchers across Western Sydney University, the nation and the world.

Central to meeting the Centre for Infrastructure Engineering's aims and Western Sydney University's commitment to achieve research excellence is the maintenance of a vibrant research environment and the recruitment of high-performing researchers and PhD candidates.

MESSAGE FROM THE DIRECTOR

Dear friends and colleagues,

It is my pleasure to provide you with an introduction to the Centre for Infrastructure Engineering (CIE) at Western Sydney University.

CIE is a world class research centre at the leading edge of Infrastructure Engineering. We focus on the analysis, design, maintenance and rehabilitation of built infrastructure. The staff at CIE are leading academics at the forefront of research and have excellent experience in directing research projects in specialised areas such as water engineering, structural systems, computational mechanics, construction materials, pavement engineering, and structural assessment and health monitoring. Most recently we have welcomed several new post-doctoral fellows to further boost the research output of the Centre in all areas of its research endeavours.

A range of scholarships, our excellent academic contacts and industry driven research projects, as well as modern testing facilities, allow us to recruit high calibre PhD candidates. Higher Degree Research graduates from CIE are not only sought after by the engineering profession for their specialised knowledge, their analytical skills and systematic approach to problem solving, they are also highly regarded for their financial and project management capabilities.

Our number of research students keeps increasing and now number over 50, with 21 successful graduates to date. CIE PhD students and post-doctoral fellows have received due recognition for their projects within the Western Sydney University community.

CIE offers highly specialised engineering consulting and research capabilities aimed at identifying practical and efficient solutions to clients' needs. This includes providing expert assessment of products, procedures and/or design criteria in the fields of construction (civil/structural) works along with providing new product support in the form of structural assessment, proof testing, and development performance.

CIE also witnessed the completion of the Dynamic Testing and Control Laboratory, as well as the Composite Laboratory. In addition, CIE acquired various test gears for Pavement Research and completed the construction of a new test frame on the strong floor of the Structural Research and Testing Laboratory for simultaneous horizontal and vertical loading of test specimens, mainly frames.

We look forward to continuing to expand our specialised staff, students and capabilities with a view to build, maintain and rehabilitate Australian and international infrastructure that billions of people rely on every day.

Professor Bijan Samali
Centre Director

SELECTED CIE PROJECTS

BRIDGE INSPECTION USING DRONES

There are now over 800,000 kilometres of roads and over 30,000 bridges in Australia. Millions of commuters rely on the transportation network. The reliability and safety of these infrastructures are crucial to the Australian economy.

Remotely Piloted Aircrafts (RPAs), commonly known as drones, have been heralded as a groundbreaking development in technology. However, very limited research has been done to investigate the benefits of this technology for use in bridge inspections.

Bridge inspection drones need to have advanced safety features considering they fly over traffic, and are subject to gusts of wind and weak GPS signals. Furthermore, the drone needs to be robust in resisting magnetic fields, as a bridge inspection drone will get close to masses of metal elements, e.g. truss bridges. Another issue is that almost all the drones in the market have a camera that is attached underneath the drone, which limits its ability to look overhead, and causes a major problem when carrying out bridge inspections.

Our Structural Assessment and Health Monitoring (SAHM) team, led by Dr. Maria Rashidi, has collaborated with Roads and Maritime Service (RMS) of NSW to trial RPAs for bridge inspections. As part of this feasibility study, qualified pilots from our team and RMS used a high-end drone to examine the effectiveness of RPAs for bridge inspections.

Several bridges with various features and configurations have been tested to determine the effectiveness of RPAs as bridge a inspection tool. This research has already sparked interest across Australia, including other states' transportation departments.

RPAs offer huge potential in undertaking visual inspections with high accuracy and reduced risk to bridge crew, allowing a bridge to be visually inspected without the need for inspectors to walk across the deck or utilise costly and often heavy under-bridge inspection units. This can significantly reduce the overall inspection costs and disruption caused to the general public. In addition to this, the use of airborne Aerial Photogrammetry enables asset managers and engineers to better understand a situation through the 3D spatial context offered by RPAs.

DR MARIA RASHIDI

LECTURER IN INFRASTRUCTURE SYSTEMS

Research interests include: bridge management systems, systematic asset management for civil infrastructure, condition assessment and remediation planning of concrete bridges, managing ancillary transportation assets, lifecycle management and risk management of civil infrastructure, and development of decision support systems for infrastructure planning.

SEMI-AUTOMATED HANDLING APPARATUS

DR PEJMAN SHARAFI

LECTURER IN STRUCTURAL ENGINEERING

Research interests include: structural optimisation, advanced structural systems, modular buildings, prefabricated construction systems, cost optimisation of structures, sustainable structures, computer aided design and parametric design.

CIE is working with the company Alspec Aluminium Systems Specialists (Alspec) to develop a remotely controlled handling machine that will help eliminate manual handling operations of long and heavy extrusions. The process currently involves manual carrying and turning of the extrusions from a horizontal to vertical position, so that they can be stored in a vertical position in the designated racks.

The proposed semi-automated equipment is designed to carry out the aforementioned operations, with the help of a mobile trolley fitted on a modified electric self-propelled scissor lift, powered by a chargeable battery. The proposed device consists of an electric self-propelled scissor lift, fully modified and redesigned with a custom-made cradle, where extrusion bundles will be loaded horizontally with the use of a forklift. The extrusion laden trolley is then transferred by the help of a driver to the racks, where the extrusions are unloaded and stored in storage aisles. The cradle is pivoted closer to one end, so that it is tilted to a vertical position as the lift rises. The cradle is tilted almost vertical, and is positioned in front of the rack so that it can be emptied easily.

SELECTED CIE PROJECTS

NOVEL GEOPOLYMER CONCRETE FOR SUSTAINABLE CONSTRUCTION

DR BABAK ABTAHI

POSTDOCTORAL RESEARCH FELLOW

Research interests include: New polymer formulations for soil stabilization/remediation and dust suppression, nanocomposites, bio-mimicking and bio-inspired, sustainable designs and formulations.

With ever increasing demand for Portland cement, the concrete industry requires novel solutions to address the challenge. On the other hand, production of Portland cement contributes to almost 7% of total CO2 emission to the atmosphere. Inorganic polymer concrete or Geopolymer could be the next generation concrete that not only combat the cement shortage but also provides a sustainable solution that provides cost effective concretes with improved performance.

Most Geopolymer mix designs are based on blending aggregates and the resulting mixture can be simply cast in the same way as Portland cement based concrete. However, it provides improvement in concrete performance such as resisting ion penetration, sulfate attack, acid attack, shrinkage and heat of hydration and durability compared to ordinary concrete.

CIE in partnership with James Hardie Industries are focusing on proprietary Geopolymer concretes to bring sustainable solutions for durable structures. The research is a great step for providing a new platform that answers the demand for urban society growth. It will be a new mix design formulation compliant with Australian Concrete Structures code and similar international standards.

For years, various parts of cementitious products have been abundant and relatively inexpensive. Also, its natural structural properties and its ease of manufacture have assured its dominant position. However, with the growth of the economy, and the emerging significance of global environmental issues such as the greenhouse effect, there is a need to re-assess the widespread use of various products in building construction. This project aims to find products with maximum compatibility with current methods and designs. At the same time, with introducing new concepts, new formulations and feasibility and development of new equipment will be employed.

ENERGY SAVING IN NEW AND EXISTING AIR CONDITIONERS

DR VAHID VAKILOROAYA

SENIOR LECTURER

Research interests include: thermodynamics, heat transfer, solar energy, fluid mechanics, industrial ventilation and HVAC sustainable development.

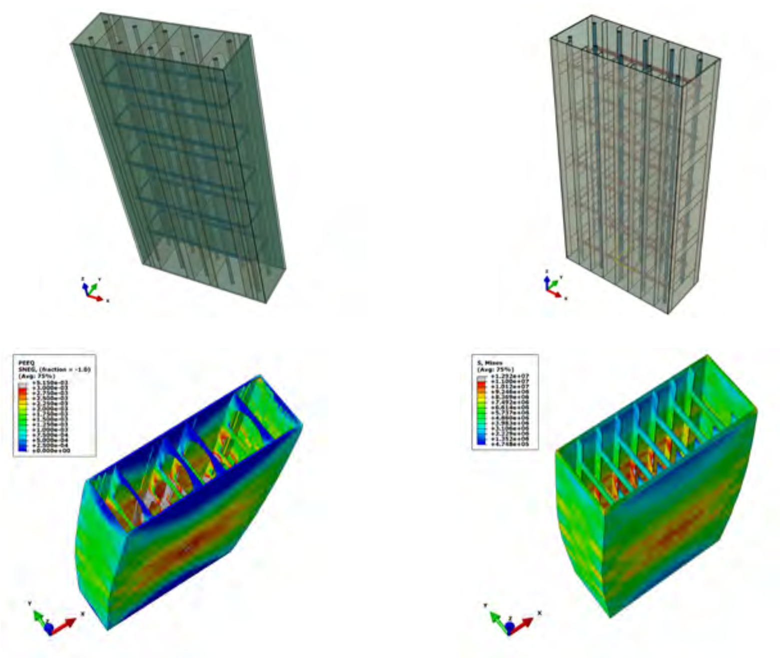
With rapid advances in science and technology, several techniques can be implemented in heating, ventilation and air-conditioning systems (HVAC) to improve their energy efficiency and reduce environmental impact. In contrast to traditional HVAC systems, energy-efficient HVAC systems boast lower energy consumption requirements, lower running costs, and reduced greenhouse gas emissions.

These systems have also been proven to play an important role in managing energy usage targets, slowing energy price growth, maintaining energy security and mitigating the impacts of climate change. Thus, widespread installation of energy-efficient HVAC systems would play a critical role in reducing peak electricity demand, as well as assisting home and building owners to manage the costs associated with indoor climate control.

Our researcher proposed a synergetic framework of the system identification, optimisation and robust control of a designed energy-efficient air-conditioning system to target energy efficiency and environmental sustainability in buildings. Field tests have been carried out and the product is in the market.

SELECTED CIE PROJECTS

STRUCTURAL PERFORMANCE OF PERMANENT FORMWORK SYSTEMS



DR KAMYAR KILDASHTI

POSTDOCTORAL RESEARCH FELLOW

Research interests include: computational mechanics, nonlinear finite element analysis, boundary element method, discrete element method, bridge health monitoring, structural dynamics, dynamic soil structure interaction, performance-based earthquake engineering, structural collapse analysis, and seismic rehabilitation of heritage buildings.

CIE experts are evaluating the structural performance of permanent formwork systems by the names of AFS-Logicwall and AFS-Rediwall, the propriety products of CSR building materials company. The aim of this research is to examine the performance of AFS panels by means of experimental laboratory tests and numerical simulations.

AFS-Logicwall panels are created by attaching fibre cement boards to galvanised steel studs to form lightweight sandwich panels. The panels can be handled on-site quickly and poured with concrete. The fibre cement board remains in place and makes a substrate for the final finishes. AFS-Rediwall panels are PVC panel systems that act as the permanent formwork for in-situ concrete columns. The extruded polymer subassemblies facilitate the concrete construction with a quick installation technique. Several samples of AFS panels, along with conventional columns in Australian practice are selected for laboratory tests.

ABAQUS software was utilised and calibrated for numerical simulations, by implementing sophisticated material constitutive laws.

NUMERICAL AND EXPERIMENTAL ANALYSIS OF BUSHFIRE-ENHANCED WIND AND ITS EFFECTS ON BUILDINGS

This project aims to investigate the mechanisms involved in the bushfire wind enhancement phenomenon and its effects on buildings.

This Australian Research Council funded project studies the effect of bushfire-enhanced wind, is being run by Prof. Kenny Kwok, Dr. Yaping He and CIE PhD student Esmaeel Eftekharian, with CIE's Dr. Ghodrat collaborating on the project since June 2017. The main objective is to numerically and analytically identify and quantify the relative contribution of the mechanism contributing to the generation of bushfire-wind enhancement. This research also aims to quantify the effects of bushfire-wind interaction to predict the consequences in terms of changes in velocity profile and pressure coefficient for known wind strength and bushfire intensity.

Bushfire protection studies, particularly those that focus on the bushland-urban interface fire protection, can generally fall into two areas: the relationship between bushfire severity and environmental conditions, and the mechanism of damage by bushfire. While many studies have treated wind as the primary driving force for fire spread, the enhancement of wind by bushfires and the damage to buildings by the resultant aerodynamic loading, combined with other bushfire attack mechanisms, have been largely overlooked. The lack of considerations for bushfire-enhanced wind and the combined action imposed on buildings subjected to bushfire attacks is evident in the relevant Australian building standards. Hence, a comprehensive study on bushfire-wind-structure interaction is urgently needed.

Once this has been achieved, pressure loads acting on different building configurations will be studied in detail to develop correlations between wind load, wind speed, bushfire intensity, building configuration and site terrain.

The models which have been developed in this study can be applied to improve the current version of building standards which do not take into account the effects of the bushfire-wind enhancement phenomenon. Improved standards will result in buildings that are more resistant to major bushfire attacks, which will yield huge socio-economic rewards.

DR MARYAM GHODRAT

POSTDOCTORAL RESEARCH FELLOW

Research interests include: thermodynamics and heat transfer, CFD simulation of fire inducing wind velocity, process modeling, advanced materials and materials for energy, high temperature processing and life cycle assessment of recyclable materials.

RESEARCH STUDENTS

PhD students are an important part of the academic workforce, as they contribute immensely to the advancement of knowledge in their scientific discipline and are the backbone of many research efforts. CIE currently supervises over fifty PhD students who engage in research from a wide variety of fields, including (but not limited to) materials engineering, structural engineering, water management, pollution control and waste management. CIE provides high level research supervision that allows research students to make considerable contributions to research and development that advances Australia's academic knowledge and the economy.

Students at CIE have access to superior research expertise and facilities. Our research focused academics are often at the forefront of their fields and have a great deal of experience in driving research projects. CIE selects and recruits high-achieving students with a proven record of academic excellence and provides them with a supportive and forward thinking intellectual environment where they can excel.

Students are supported through the Research Training Scheme, scholarships and fee waivers from CIE and Western Sydney University, and the Australian Postgraduate Awards (APA), as well as scholarships offered and funded by our industry partners.

A range of scholarships are offered to high-achieving students wishing to undertake research at CIE. Higher degree research graduates from CIE are not only sought after by the engineering profession for their specialised knowledge, analytical skills and systematic approach to problem solving, but they are also highly regarded for their financial and project management capabilities.

THE ADVANTAGES OF PURSUING A PHD AT CIE.

- → The opportunity to work on real world projects funded by the Australian Research Council (ARC) and/or industry, that help to inform future Australian Standards in Infrastructure Engineering.
- → Access to some of the best testing and research facilities in Australia.
- → Being part of the vibrant and growing Western Sydney region and beautiful Kingswood campus.
- → Potential to secure employment with industry partners after graduation, as well as post doctoral opportunities.
- → Being supervised by expert and experienced supervisors in a caring and supportive environment.

SELECTED STUDENT PROJECT: IN-PLANE BEHAVIOUR OF COMPOSITE COLD-FORMED TRUSS FLOORS

SOHEILA PEYROVI CHESHNASAR

PHD CANDIDATE

Thesis Title: In-Plane Behaviour of Composite Cold-Formed Truss Floors

PRINCIPAL SUPERVISOR: PROFESSOR HAMID RONAGH

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Ms Soheila Peyrovi is a PhD student undertaking research in the area of 'Cold-Formed Truss Floor Systems'. She is studying the behaviour of composite cold-formed truss diaphragms with furring channel as shear connectors.

Soheila's research into this area includes testing of two full scale concrete slabs under in-plane loading. The test evaluates the static shear capacity and stiffness of a typical segment of a framed diaphragm under simulated loading conditions, current design codes are based on non-composite slabs or composite slabs with headed stud connectors. Finally, numerical analysis for classification of these diaphragms as flexible, semi-rigid or rigid, are conducted in multi-storey buildings.

A test rig was designed and fabricated. The system consists of three elements; concrete slab on corrugated cold-formed metal deck, cold-formed steel truss joists, and cold-formed furring-channel shear connectors. Normal concrete with the thickness of 65 mm from top of metal deck is representative of a floor slab. Two layouts are tested: joists perpendicular to the applied load, and joists parallel to the applied load (joists are rotated 90°).

This is one example of the many projects and experiments carried out at CIE. We currently supervise, support and test projects for over 50 PhD students, as well as for numerous academics and external partners.

Soheila started her PhD program at the Centre for Infrastructure Engineering in Western Sydney University in 2015 after receiving her Master's by research degree from Amirkabir University of Technology for her thesis 'The Effect of Boundary Members on the Buckling and Post-Buckling Behaviour of Curved Plates'.

FACILITIES

STRUCTURAL DYNAMICS AND CONTROL LABORATORY

DYNAMIC TRIAXIAL TESTING

When designing new roads and highways, understanding and quantifying the performance of different unbound bases, sub-base materials and bound materials (asphalt layer) is of key importance.

The Dynamic Triaxial Testing machine supplied by GDS is an apparatus combining a triaxial cell with a dynamic actuator capable of applying load, deformation and stresses of up to 20Hz. The permanent deformation tests can be carried out in the CIE dynamic lab using this dynamic triaxial apparatus on specimens with 150 mm and 100 mm diameters. In this testing machine, the axial axis is screw-driven from an integral base unit housing the motor drive. Axial force and axial deformation are applied through the base of the cell. The environmental chamber is capable of controlling the temperature of specimens ranging from -20°C to 60°C. The system would also have the capability to log the data obtained from the various sensors.

In addition, the capability of this apparatus has been extended to cover the Indirect Tensile Test for Resilient Modulus of Asphalt.

The software module included in this apparatus is a desirable accessory to enhance the capability of the machine. This option will unlock the full functions of the machine and allow the user to define square, triangular and other waveforms.

CAPABILITIES

- → Frequency: 20 Hz
- → Maximum Dynamic load: 20 kN
- → Temperature range: -20°C to 60°C
- → Confining pressure: 2 MPa
- → Loading frame: for up to 50 kN load

LAB SUPERVISOR: PROF BIJAN SAMALI

Research interests include: structural dynamics and its applications to wind and earthquake engineering and blast loading (particularly structural vibration control caused by environmental loads), dynamic assessment and health monitoring of bridges, smart building facades, and special performance concrete.

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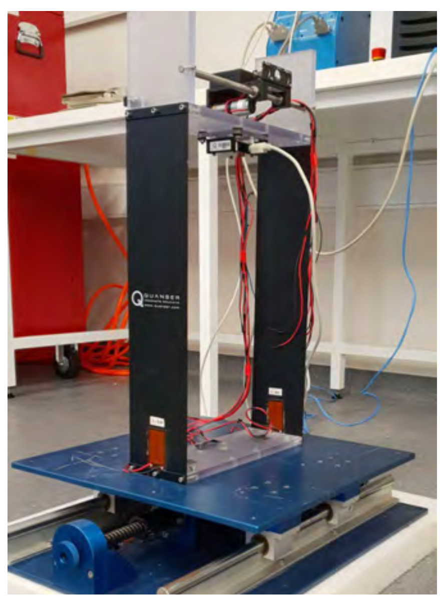
SHAKE TABLE

There are two mid-size open-architecture single-axis Quanser shake tables at CIE, which together can be used as a 2D earthquake simulator and therefore suitable for structural dynamics, vibration isolation, feedback control, and other control topics related to earthquake, aerospace and mechanical engineering. Users can generate sinusoidal, chip as well as pre-loaded acceleration profiles of real earthquakes, such as Northridge (1984), Kobe (1995) and El-Centro (1940), to study their effects on buildings, bridges and various materials.



INFRASTRUCTURE HEALTH MONITORING LABORATORY

An automated scan mechanism for the microwave imaging system

Piezoelectric-based sensor setup

Material characterisation system and a sensor/ antenna measurement setup

The Sensor Technology for Infrastructure Health Monitoring Laboratory at CIE was established in March 2013. The Laboratory has been equipped with modern sensor technology systems, and setup for microwave and millimetre wave material characterisation, nondestructive testing (NDT) and evaluation of composite structures (for local structural health monitoring), and the development of new microwave sensors and antennas.

Sensor technology facilities and scope include:

- A novel microwave imaging system that integrates an Agilent performance network analyzer (PNA) operating from 100 MHz – 50 GHz, and an automated multifunctional scanner to generate images of composite materials and structures for nondestructive testing (NDT) and evaluation of their integrity.
- A material characterisation system providing the determination of dielectric constant of materials, including construction materials such as cement-based materials (at several stages of their life) and their ingredients using an Agilent PNA, microwave sensors and antennas, and commercial and custom-made software.
- Ultra Wide Band (UWB) smart sensor system based on Time Domain PulsON 440 radios for two-way ranging and location identification (e.g in Smart Home applications).
- A sensor and antenna measurement setup for testing existing and novel microwave sensors and antennas for material characterisation and structural health monitoring. This setup includes the Agilent PNA and an Agilent signal analyser capable of operating up to 40 GHz.

LAB SUPERVISOR: DR RANJITH LIYANAPATHIRANA

Dr Ranjith Liyanapathirana is a Senior Lecturer in Telecommunications. He earned his PhD in 1995 from Memorial University of Newfoundland, Canada. His research interests are wireless communication, sensor systems and networks, and structural health monitoring. He has published over 150 refereed papers in IEEE/IET conferences and journals. He is a senior member of the IEEE Instrumentation and Measurement Society and the Australia Computer Society (ACS).

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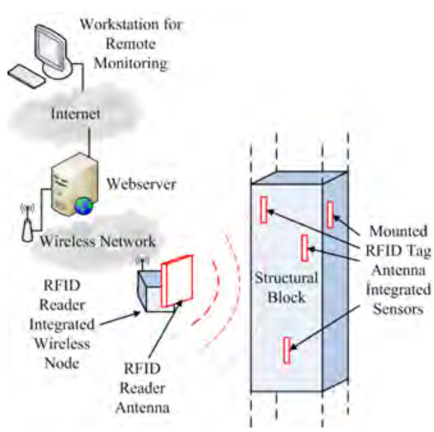


FACILITIES

MATERIALS TESTING LABORATORY

The Materials Testing Laboratory at CIE can be used by experts to measure mechanical properties of construction materials at ambient and elevated temperatures. The laboratory is equipped with the following machines for use in the research of construction materials.

INSTRON 8036 TESTING MACHINE

Features:

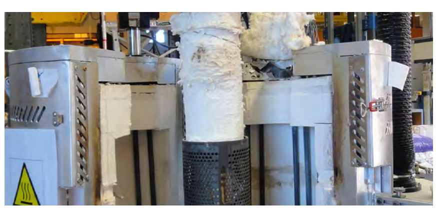
- Up to ±1000 kN (220 kip) axial force capacity
- Four columns, high-stiffness, and precision-aligned load frame
- Hydraulic lift and locks of upper crosshead
- Actuator in upper crosshead
- Vertical daylight options to suit test application
- Dynacell load cell features compensation for inertial loads caused by heavy grips and fixtures
- Range of grips, flexure fixtures, compression platens and other accessories
- Hydraulic performance to suit application

INSTRON 6027 TESTING MACHINE

Features:

- Load measurement accuracy: +/- 0.5% of reading down to 1/1000 of load cell capacity option
- Up to 2.5 kHz data acquisition rate option simultaneous on load, extension, and strain channels
- Speed range of 0.00005 to 1016 mm/min (0.000002 in/min to 40in/min)
- Automatic transducer recognition for load cells and extensometers
- 100 kN (22,500 lbf) capacity
- 1430 mm (56.3 in) vertical test space
- Testing at high temperature up to 1400 °C

The Morris Heckenburg Furnace can be used to test columns (up to 250´250´2000 mm^3) and other components which can be fit in the chamber (630´640´880 mm^3). The measurement range is from ambient to 900 °C.



The bore split tube furnace can be used to test blocks made from concrete, mortar, timber or other materials (up to 150´150´300 mm^3). The measurement range is from ambient to 1200 °C.

LAB SUPERVISOR: PROF ZHONG TAO

Professor Tao has a research background in the areas of construction materials, steel-concrete composite structures and structural fire engineering. He has in excess of 300 publications (including two books and over 170 referred journal papers) with a Scopus h-index of 29. He has been successful in attracting competitive research grants and supervised over 70 higher degree research students.

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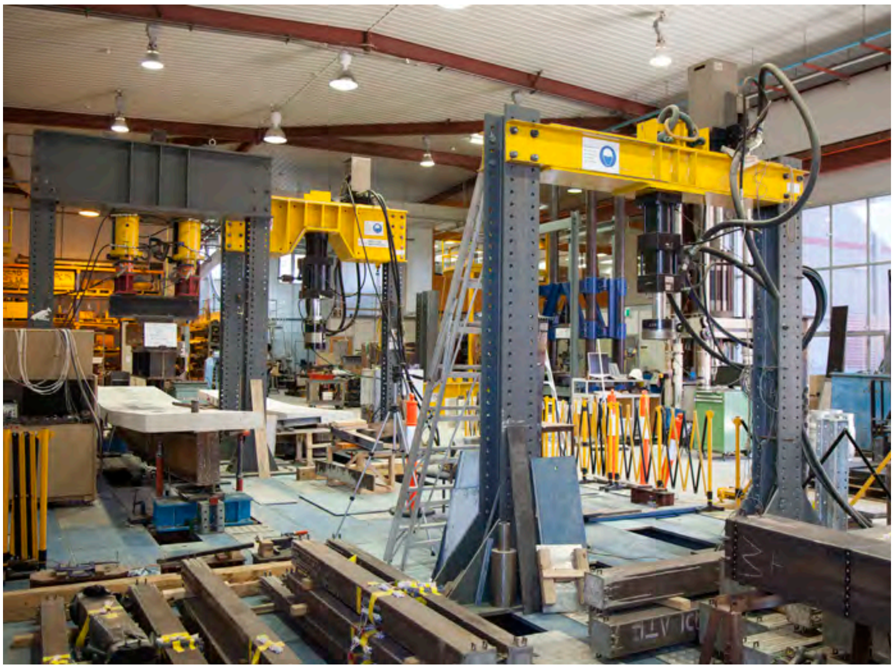
STRUCTURAL RESEARCH AND TESTING LABORATORY



The Structural Research and Testing Laboratory (SRT) at CIE is one of the best testing and research facilities in Australia. Structural Testing facilities and scope include:

- Multi-purpose structural testing facility for testing specimens and assemblies up to 4m high at: - 10,000kN (1000 tonnes) static compressive load;
  - Simultaneous 1000kN lateral fluctuating load at 3 Hz;
  - Simultaneous loading with dual actuators at 500kN tilting load, each at 3Hz synchronous or asynchronous loading.
- A multi-configurable strong floor of 16 m x 8 m with numerous actuators ranging from 150 kN to 2000 kN, built to complement the above frames
- Impact testing of materials using a Split Hopkinson Pressure Bar
- Testing for dynamic characteristics of structures, concrete floors, buildings, assemblies, modal analysis for structures and assemblies

Another feature of the SRT lab is the panel vacuum testing rig specifically designed to test walls under uniform pressure and in their natural vertical position. The walls are assembled horizontally at the working height level and are then pulled into the rig by an electric winch. A special loading regime is automatically applied in a fully controlled state by means of pressure sensors, displacement transducers and a highly accurate data logging device. The system allows running hundreds of tests with minimum operator time or effort. The uniform application of load by means of vacuum, vertical operation and horizontal assembly in addition to its enormous size being capable of testing walls up to 6.5 m tall makes this rig very unique.

Research and industry consultation projects carried out at the SRT are served by a state of the art instrumentation and data acquisition system. This is backed by a CPU/GPU based High Performing Computer cluster with computational power of 2060 GigaFLOPS (one GigaFLOP is equivalent to one billion (109) floating-point operations per second).

LAB SUPERVISOR: PROF HAMID RONAGH

Research interests: overwrap repair of subsea pipelines, mitigating the risk of post-earthquake fire failure, innovative construction technologies, hybrid hot-rolled/cold-formed systems, response of composite cold-formed steel-concrete floor systems to vibration, and the progressive collapse of structures.

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The panel vacuum testing rig.

FACILITIES

COMPOSITE LABORATORY

LAB SUPERVISOR: DR NARIMAN SAEED

Research interests include: Repair of steel pipelines with composite overwraps, rehabilitation and retrofitting of steel structures with FRP, composite of timber and FRP, reliability of structures, application of FRP composites in prefabricated construction, sustainable structures, non-linear FE modelling.

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The composite lab at Centre for Infrastructure Engineering is designed for manufacturing composite materials and evaluating durability of different materials in harsh environments. This laboratory has recently been established, the scope and facilities include:

- → Composite manufacturing methods including laying-up of prepreg materials, vacuum bagging, wet lay-up, resin infusion.
- → Thermal press is used for processing thermoplastic materials which require a high temperature and high pressure. The press has a 400 x 400x 200 mm working volume reaching temperatures up to 300 °C and loading up to 25 tons. The thermal press has an integrated water-cooling system, which allows fast cooling rates. The PID temperature controller system allows both the heating and cooling rates to be controlled during processing.
- → CIE composite lab possesses a large oven with the internal dimensions of 700 x 640 x 900 mm for processing composite materials, such as curing of thermoset resins, and high temperature resin infusion. The oven can reach a maximum temperature of 300 °C.
- → Large fume cupboard is used for the process which requires high ventilation to be undertaken. These typically consist of mixing resin component, or the use of solvents for cleaning tools.
- → Having large Environmental Chamber and salt Spray chamber, CIE composite lab is able to evaluate durability of different materials in harsh environment. Technical specifications of these chambers follows:

ENVIRONMENTAL CHAMBER:

Internal Dimensions 1000 x 1000x 1000mm
Temperature: -20°C R150 °C
Humidity: 30%~98%R.H
UV (340nm)
Water Spray Time: 0~9999min, Programable

SALT SPRAY CHAMBER

Internal Dimensions 1000 x 1000x 1000mm
Programmable spraying

ADVANCED RESEARCH LABORATORY FOR HYDRAULIC ENGINEERING

CIE has been very fortunate to have Associate Professor Alireza Keshavarzy join us. Under A/Prof. Keshavarzy's supervision, we are starting up a new research area that we have previously lacked expertise in, the area of flow-structure interaction and Hydraulic Engineering. This research area has a lot of synergy with many of our other projects and research goals.

Central to this new area of research will be the experimental flume. Large scale and modern laboratories are always critical in attracting high quality students and academics. And until now there has been no large scale experimental flume at WSU.

The focus of our Advanced Research Laboratory for Hydraulic Engineering is to find solutions for the prevention of bridge collapse due to scouring and hydraulic problems during flood events.

The facilities and scope are:

- Large Experimental Flume with the dimension of 1m (width), 0.8m (height) and 16 m (length). The slope of the bed is also adjustable. It is a recirculating flume with the capacity of 120 lit/sec flow rate and can be upgraded to 240 lit/sec. The flow rate is measured using Electromagnetic Flow meter with high accuracy. The floor and wall are built with glass to enable a visualisation of flow and sediment particles transport. It is unique in Australian universities in terms of the dimensions and the adjustable bed slope.
- Simultaneous 3-D Acoustic Doppler Velocimeter with the rate of 50 Hz (Micro-ADV). It can measure three dimensional flow velocity of flow at any point of flow with the rate of 50 samples per second.
- Very High Speed Camera, enables the capture of images using a high frame rate. The images are stored for later analysis.
- Simultaneous 3-D ADVP for flow velocity measurement enables the measurement of flow velocity simultaneously at 30 points in a vertical line with the rate of 100 Hz.
- PIV Velocimetery Technique

Clockwise from top left: PIV, ADV, ADVP, Electromagnetic Flow Meter, Pump, VSD.

LAB SUPERVISOR: ASSOCIATE PROFESSOR ALIREZA KESHAVARZY

Research interests: bridge pier scouring, river engineering, sediment transport, water resource engineering, environmental engineering, computational fluid dynamics, river meander and vegetation, debris flow, flow-structure interaction.

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FACILITIES

ADVANCED MATERIALS CHARACTERISATION FACILITY

Western Sydney University has an Advanced Materials Characterisation Facility (AMCF) that is home to a suite of state-of-the-art instruments for materials characterisation. The AMCF specialises in assisting researchers, students and industry with material analysis and characterisation.

The AMCF has a wide variety of instruments for material and biological characterisation including:

Imaging Instrumentation:

- Zeiss Merlin SEM (FEGSEM and microanalysis)
- SEM JEOL 7001F (FEGSEM, X-ray Mapping and microanalysis)
- SEM JEOL 6510 LV (Low Vacuum with EDS microanalysis)
- JEOL EM Probe 8600 (EDS/WDS and XRM)
- Phenom Desktop SEM with Microanalysis
- Digital Nanoscope III AFM

Thermal Characterisation Instrumentation:

- TGA/DSC Netzch STA449C Jupiter
- DSC Netzch 204 F1 Phoenix
- Simultaneous evolving gas analysis by infrared spectroscopy (FTIR) and TGA/ DSC
- Thermal Mechanical Analysis (TMA)
- Surface Area and Porosity Analyser (Micromeritics ASAP 2020).

Vibrational Spectroscopy (FTIR and Raman).

- Mid infrared microscope Hyperion 1000 attached to the Bruker Vertex 70 spectrometer
- Hybrid Fourier Transform/Dispersive Raman microscope Bruker Ramanscope III Senterra
- Combined Fourier Transform Infrared/ Raman spectrometer Bruker Vertex 70 & RamII Module.

Other Instrumentation:

- Bruker D8 Advance Powder Diffractometer (XRD) with High Temperature stage and grazing incidence
- Surface Area and Porosity Analyser (Micromeritics ASAP 2020)
- Critical Point Dryer (CPD)
- Sample preparation equipment
- Optical Microscopes
- Coatings Units

The AMCF instruments can been used for:

- The characterisation of materials and biological structures at the micro and nano scales.
- Identifying elements & compounds.
- Characterising chemical composition (X-ray analysis and mapping).
- Thermal analysis.

Located at the Parramatta South campus the AMCF offers:

- Access to state-of-the-art expertise and instrumentation.
- Research support.
- Training in use of instrumentation.
- Range of short course and workshops. These include SEM, EDS, XRM, XRD, Raman, Thermal Characterisation and Instrumentation Maintenance.
- Contract research and development.
- Grant aided research.
- Testing services.
- Fee for service and direct access (priority access is available to industry on request).

RESEARCH MANAGER: DR RICHARD WUHRER

Dr Wuhrer has extensive experience on various scanning electron microscopes, variable pressure and environmental scanning electron microscopes, microanalysis systems, X-ray mapping and X-ray diffraction. He has taught many courses and workshops in the field of Characterisation techniques, SEM, ESEM, EDS, WDS, XRM, EM Maintenance, GSR, Forensic Characterisation techniques, EM Probe and XRD. Richard has a PhD in Applied Science from UTS and is the President of the Australian Microbeam Analysis Society (AMAS). He has over 80 reviewed publications on a variety of topics from art works to gunshot residue analysis, surface engineering and development of new alloys, but his main focus remains characterisation techniques and further development of these techniques through combining systems and aiding in the analysis of materials and biological materials.

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