WESTERN SYDNEY
UNIVERSITY

Engineering, Design and Built Environment

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Ground Improvement using Chemical Stabilisation

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Supported by: Professor Chin Leo and Dr Pan Hu

Research area: Geotechnical engineering

In this project, ground improvement methods based on chemical stabilisation are investigated. Special emphasis will be given to alkaline activation and application of waste materials to enhance the bearing capacity of clay soils and to reduce the swelling characteristics due to moisture migration in clay soils. Changes to the clay structure due to chemical stabilisation will be investigated using advanced material characterisation tests such as X-Ray diffraction methods quantifying the mineral composition of clay before and after treatment. Also changes to the index properties and swelling characteristics will be investigated using Atterberg tests, swelling tests and CBR tests according to the Australian standards. Another aspect of this project is development of constitutive models for chemically stabilised soils using a range of triaxial tests investigating soil behaviour under both monotonic and cyclic loading conditions and temperatures relevant to extreme climatic conditions in Australia.

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Soil-Structure interaction issues in Integral Abutment Bridges

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Supported by: Professor Chin Leo and Dr Pan Hu

Research area: Geotechnical engineering

Integral Abutment Bridges (IABs) are built by integrating the superstructure with the abutments, without any expansion joints. IABs are often preferred over conventional bridges with expansion joints due to lower construction and maintenance costs. However, there are some limitations from the point of view of Geotechnical engineers. Majority of these limitations are related to the expansion and contraction of the superstructure due to temperature fluctuations. The active and passive pressure cycles developed within the retained backfill causes build-up of lateral earth pressures acting on the abutment, which is called stress ratchetting. It can have significant detrimental effects on the superstructure and abutments. As a result of cycling, a settlement trough is also developed behind the abutment and the magnitude of this settlement can be significant. Normally the length of IABs are limited to reduce the stress ratchetting and settlements at the bridge approach. The current understanding of above mentioned issues are inadequate and the IAB design is mostly dependent on idealisations and simplifications in relation to soil-structure interaction issues.

The aim of this project is to identify the significance of temperature changes and subsequent soil-structure interaction effects. Both advanced numerical modelling and scaled laboratory model tests will be utilised to identify and mitigate adverse effects of these cyclic movements. As a result, super-long IABs can be designed to achieve satisfactory performance.

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Nondestructive Damage Detection in SHM using Microwave and Millimeter Wave Scanning

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Supported by: Dr Robert Salama

Research area: Electrical and electronic engineering, Nondestructive testing, Structural health monitoring, Sensor networks, Distributed damage detection, IoT devices

Structural Health Monitoring has recently attracted much attention among civil, electrical and electronic engineering researchers due to the need to monitor large civil infrastructure such as bridges, buildings and tunnels. Increasingly, IoT devices are used to accomplish this function. In this research we detect and localise damage in structures using millimeter and microwave techniques. The Centre of Infrastructure Engineering's Infrastructure Health Monitoring (IHM) Lab at Western Sydney has a 3D microwave scanner, and data collected using this precision instrument can be analysed and transmitted using distributed sensors or IoT devices for real-time monitoring purposes. The Infrastructure Health Monitoring Lab has facilities to design, simulate, and the experimental evaluation of all types of microstrip antennas. Many opportunities are available for local damage detection, embedded sensor design and system development for integrated RFID sensors. As part of a small team of dedicated and supportive researchers and research students you will be able to develop your research skills (computer simulation using CST and experimental methods using a high performance network analyser and other high-end RF equipment) leading to quality IEEE publications.

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Developing a Liquid Waste Management Framework for Construction Projects

Professor Srinath Perera: srinath.perera@westernsydney.edu.au

Supported by: Associate Professor Mary Hardie

Research area: Waste management and sustainability

Construction and demolition waste generated in construction projects is a significant major factor that impedes aspects of sustainability as well as impacting sustainable development goals. There are many processes and protocols in managing construction and demolition waste. However, liquid waste generated in construction projects is an important component of construction waste that is hardly regulated and inadequately researched. It is important to understand the key procedures of construction wastewater management that are followed from the waste generation phase to the destination phase even beyond a construction site. This requires the identification of the sources of wastewater, methods of handling, storing, processing, and disposing of wastewater, the waste management services employed on-site, and any issues related to wastewater management. This research aims to develop a liquid waste management framework that defines and identifies all stakeholders and processes involved from source to destination.

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Optimising Environmental Parameters of Houses using BIM and Digital Twin Technologies

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Supported by: Dr Ali Hellany, Dr Maria Rashidi and Dr Tosin Famakinwa

Research area: Sustainability

Housing is one of the largest sectors in the construction industry with over 10 million houses recorded by 2020. The environmental impact it creates is significant and has implications for all aspects of sustainability (environmental, social, and economic). Making houses smart makes it not only livable but socially, environmentally, and economically sustainable. The advent of sensor technology and Internet of Things (IoT) capabilities provide a great opportunity to make houses respond to changes in environment and social behaviour. This project aims to develop a BIM based digital twin that senses changes in housing conditions and to automate its response. It will use IoT capabilities to detect variations in conditions and record it in a Building Information Model. It will then covert the model to a digital twin representing the housing conditions in a digital environment. The research will experiment on analysing building use and environmental parameters to develop methods for optimising these parameters and energy consumption.

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Bubbledeck System in Composite Steel-concrete Structures

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Research area: Structural engineering

Bubbledeck is one of many types of void formers used in construction today, whilst the technology is still finding its feet in the regular use for construction and design the research and possibilities of the material is endless. The void formers are created from a high-density polyethylene plastic to various sizes from recycled materials making them highly sustainable and relatively cheap.

The Bubbledeck being a new method of construction for slabs is unique in the way it behaves and in the way it is constructed. The Bubbledeck slab works as a biaxial slab with the bubbles lying in the neutral axis of the slab where no considerable forces lie, meaning that the area that was once filled with concrete really serves no purpose. The bubbles can be placed in the slab and remove up to 35% of the required concrete equally reducing the amount of greenhouse gas emissions created from the production of the concrete and with the subtraction of the dead weight usually standard in the slab the spans can be increased less supporting structures.

The aim of the project is to determine whether the Bubbledeck void formers have an impact on the shear connection in composite materials through testing of the various specimens and provide a conclusive and succinct report detailing findings and results of the various tests.

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Ultra-Lightweight High Performance Concrete (ULHPC)

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Research area: Concrete design

The high demand on finite resources and the current push to produce more environmentally friendly products, particularly in the construction industry, has led to the ongoing research into and the development of materials, including concrete. As demand increases and research and technology strengthens, concrete technology improves. Research shows that waste using waste products in concrete is an effective way of improving sustainability and can also improve qualities of the concrete mix.

The use of waste products such as fly ash in concrete has led to the development and improvement of lightweight concrete. However, the same research also suggests there is a difficulty in achieving both high performance and ultralight weight concrete as there is a consistent compromise between strength and low density.

The overall objective of this project is to determine a suitable mix design to produce an innovative ultra-lightweight, high strength concrete using practical testing.

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A Blockchain Based Integrating Life Cycle Assessment Tool for Construction Projects

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Supported by: Dr Sepani Senaratne and Associate Professor Xiaohua Jin

Research area: Sustainability

Carbon is the metric to measure level of sustainability achieved in construction projects. Buildings have a life cycle and carbon emissions therefore span from its construction to end of life. Analysing carbon emissions and evaluating the state of carbon emissions in construction projects is an important parameter to decide whether a particular design solution is more sustainable or not. Previous research has developed strategies to capture embodied carbon emissions in the supply chain using blockchain solutions. This research project aims to develop a methodology to analyse and optimise carbon emissions considering life cycle carbon emissions for alternative supply chains using a blockchain protocol. It will review current sustainability assessment methodologies, in order to develop a blockchain protocol for implementation of these methodologies in a transparent and trusted environment.

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Managing Construction Industry Knowledge Through Blockchain Technology

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Supported by: Professor Srinath Perera and Associate Professor Xiaohua Jin

Research area: Knowledge management in construction

In the construction industry, knowledge management is usually associated with transfer of project knowledge to manage organisational knowledge. However, there is wide-spread knowledge such as procurement methods, contract forms, standards and good practices at industry level that is fragmented and located with various stakeholders such as consultants, contractors, suppliers, policy makers and professional bodies. This project will analyse the case in NSW and will aim to integrate fragmented usable industry knowledge through blockchains, so that key stakeholders could tap into this knowledge and use in appropriate decision-making. The output of the project will be to create a prototype blockchain connected to key stakeholders that store and share industry-level knowledge for better knowledge management at industry level.

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