Current Research Topics

BTCM
Building Technology,
Construction Materials & Management

Topic 1. Mechanics of construction materials

Flexural Behaviour of Textile Reinforced Concrete (TRC): Experimental Study and Design Implications

Textile Reinforced Concrete (TRC) is a composite material strengthened with non-metallic textiles, which significantly enhance its tensile capacity and fracture toughness. TRC has a wide range of applications, from retrofitting and strengthening existing structures to free-form lightweight elements and architectural facades. Although its tensile behaviour has been extensively studied, comparatively less attention has been given to its flexural performance. Since one of the primary applications of TRC is in the form of standalone panels and sandwich panels, both of which are predominantly subjected to flexural loading under varying boundary conditions. This study aims to experimentally investigate the flexural behaviour of TRC under different support conditions and to further elaborate on the design and fabrication aspects of such systems.

Keywords: Textile reinforced concrete, flexural, sandwich panels, design, fabrication

Pre-requisites, if any: Basic knowledge of reinforced concrete design, finite element analysis, basic programming skills (C/C++/MATLAB/Python)

Any other information: Student should be interested in laboratory work.

Faculty advisor
Dr. Keerthana Kirupakaran

Topic 2. Mechanics of construction materials

Fatigue behaviour of Steel Fibre Reinforced Concrete (SFRC) Systems

Steel Fiber Reinforced Concrete (SFRC) has emerged as an effective material for bridge strengthening owing to its superior mechanical properties compared to conventional concrete. It is commonly applied in thin overlays for bridge decks, where it improves flexural capacity and fatigue resistance while adding minimal dead load. However, despite its advantages, relatively limited research has been carried out on the fatigue performance of SFRC, both experimentally and analytically. Furthermore, mechanics-based methods to reliably predict the fatigue life of SFRC systems are scarcely explored. This study aims to address this gap through a combined experimental and analytical investigation of SFRC systems under fatigue loading.

Keywords: SFRC, fatigue, mechanics, analytical, experimental

Pre-requisites, if any: Basic knowledge of reinforced concrete design, and finite element analysis, basic programming skills (C/C++/MATLAB/Python)

Any other information: Student should be interested in laboratory work.

Faculty advisor
Dr. Keerthana Kirupakaran

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Topic 3 (for MS): AI-Enhanced Acoustic Emission–Informed Mechanistic Modeling of Fracture in Concrete Composites

Acoustic Emission (AE) is a real-time damage monitoring technique widely applied in structural health monitoring of bridges and in fracture characterization of composite materials. In the context of concrete, AE has been extensively used to study fracture behaviour, with source localization techniques enabling the identification of crack initiation and propagation within the material. This study aims to develop a framework that leverages AI models trained on AE data to predict crack patterns in concrete and concrete composites. Furthermore, AE-driven physicsbased models will be explored to enhance the predictive capability and reliability of these approaches.

Keywords: Artificial intelligence, Acoustic Emission, Concrete Fracture, data-driven

Pre-requisites, if any: Basic knowledge of reinforced concrete design, and finite element analysis, basic programming skills (C/C++/MATLAB/Python)

Any other information: Student should be interested in laboratory work.

Faculty advisor
Dr. Keerthana Kirupakaran

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Topic 4.

Multi-Robot Collaborative Systems for Automated As-Built Data Collection on Construction Sites

This work investigates the deployment of multi-robot collaborative systems for automated as-built data collection on construction sites. By leveraging autonomous ground and aerial robots equipped with advanced sensing and mapping technologies, the system enables continuous and synchronized site monitoring. The collaborative framework allows robots to share information, coordinate tasks, and adapt to dynamic site conditions, thereby improving the accuracy, speed, and safety of as-built documentation. This approach reduces reliance on manual surveys, streamlines progress tracking, and provides reliable data to support construction management, quality assurance, and decision-making.

Faculty advisor
Dr. Aritra Pal
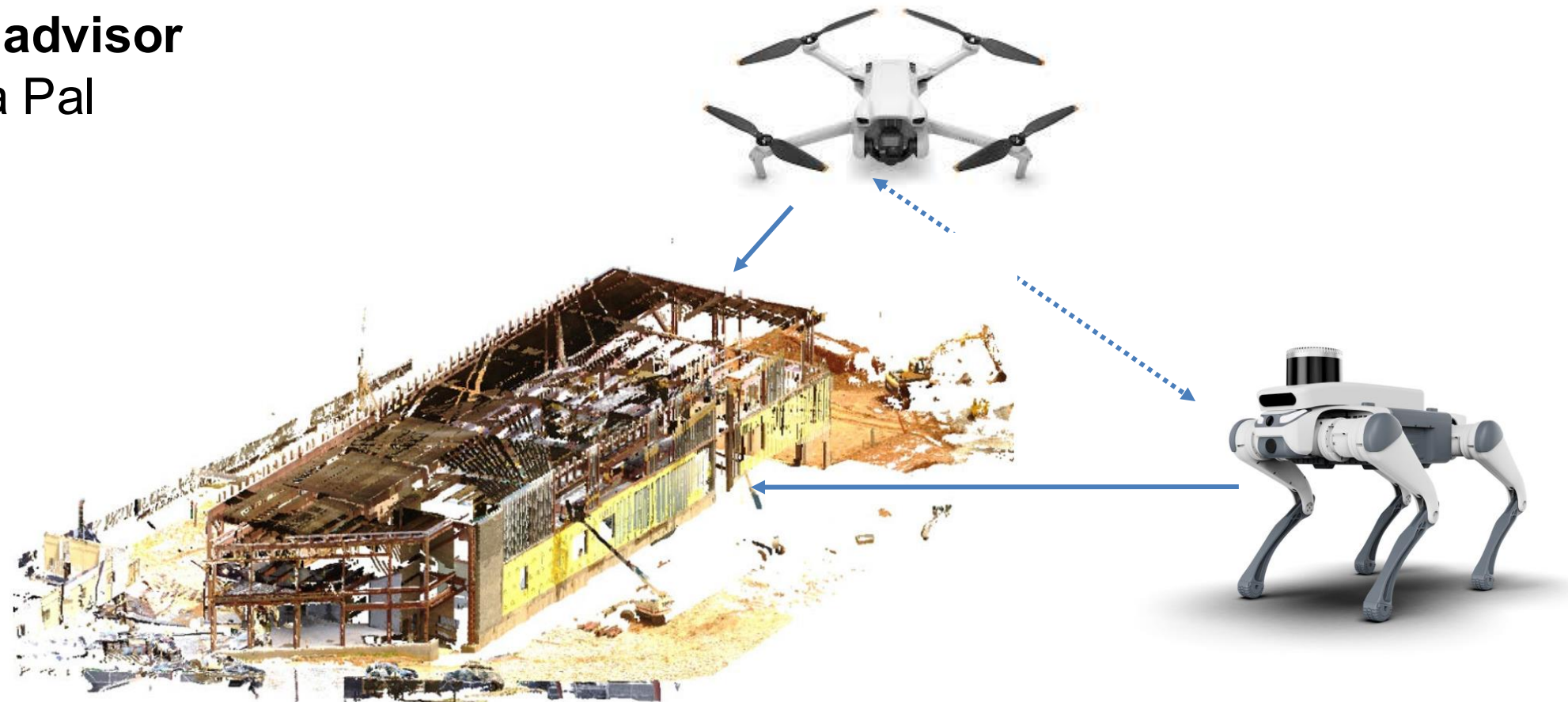
Topic 5.

Construction Quality Assurance through Digital Twin Technology

Digital Twin technology leverages point cloud data alongside BIM models or 2D drawings to create an accurate, real-time virtual representation of a construction project. Continuous comparison of the as-built conditions with design specifications enables early detection of deviations, structural inconsistencies, and quality issues. This approach not only improves construction accuracy and compliance with standards but also reduces rework, enhances decision-making, and optimizes overall project efficiency through predictive insights and continuous monitoring.

Faculty advisor

Dr. Aritra Pal

Topic 6.

C'TWIN: Development of a construction twin for real-time monitoring of project progress and resource allocation.

Digital Twin technology is transforming construction management by providing real-time, data-driven insights through the creation of virtual replicas of physical construction sites. In this research, we plan to develop C'TWIN (Construction Twin), which uses digital twin technology to dynamically monitor construction projects, integrating data from vision sensors and Building Information Models (BIM). C'TWIN will enable real-time tracking of project progress and resource allocation, allowing for predictive analytics and automated alerts. By synchronising the digital and physical environments continuously, C'TWIN aims to enhance decision-making, improve productivity, and reduce project delays.

Faculty advisor
Dr. Aritra Pal

360 Camera

LiDAR Scanner

Drone

Stereo Camera

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Topic 7. (MS)

Construction Contract Management Regimes in India and Other Countries: A Comparative Analysis to Explore Synergies towards Mitigating Disputes in the Construction Industry

The Indian Infrastructure sector is witnessing a steady growth in government investment in construction projects. While this is a good development, the performance statistics of completed construction projects indicate a growing trend of cost and time overruns, often due to recurring issues. This results in repetitive contractual claims and disputes, typically landing in arbitration or courts for a protracted dispute resolution. While reliance is on past legal precedents, which sometimes are conflicting, the absence of a dedicated construction-focused legal framework has crippled the industry from learning from the past and institutionalising better contract drafting and construction management practices. However, some countries have adopted such construction-focused legal regimes. This study reviews the prevailing framework governing construction execution, management and dispute resolution in India and juxtaposes the same with International practices, with a specific focus on the USA, the UK, Malaysia and South Korea. Through this, it is aimed at identifying the possible legal frameworks that can help implement innovative construction contract management practices, promoting reduced disputes and thereby ensuring within-budget and timely completion of public sector construction projects.

Faculty advisor
Dr. Murali Jagannathan

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Topic 8. (PhD)
Using Artificial Intelligence to Detect Irregularities in Tender Drafting and Submitted Bids

The tendering process is a core activity in public sector construction projects. However, such processes frequently face legal battles with bidder(s) challenging the contents of the tender documents and the process adopted in awarding the contracts. While such issues can delay the delivery of key public sector infrastructure projects, it is very important to maintain the integrity of the entire process. Fortunately, data from past court cases provides valuable information regarding possible legal issues, and this information can be used to train AI models to predict possible inconsistencies in the current tender documents and take suitable corrective and preventive actions before the tender is published. Additionally, it is also possible to define certain validated rules for bid compliance checking and develop models that can automatically assess the bid responsibility and responsiveness, thereby minimising errors and inconsistencies owing to human bias. This study will involve using data from past court cases and public tender documents to come up with a Proof-of-concept to automatically detect tender irregularities and an unbiased assessment of submitted bids.

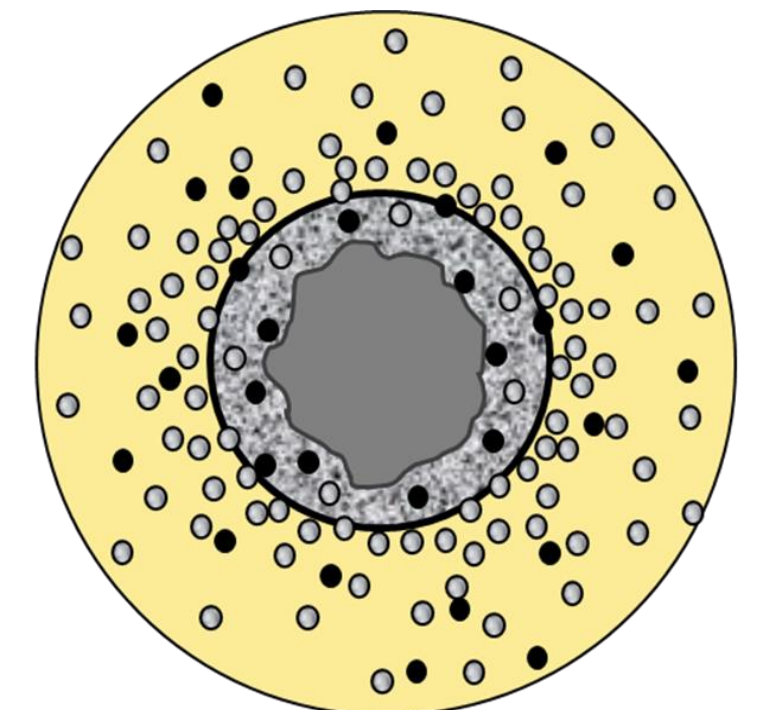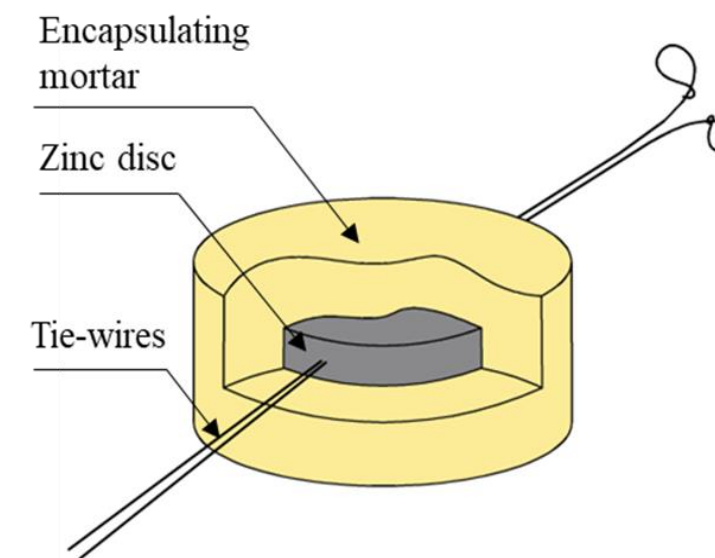**Faculty advisor**
Dr. Murali Jagannathan

Topic 9. (PhD) Corrosion Control

Extending the service life of corroding concrete structures by 50 years by using galvanic cathodic protection

Corrosion of steel in concrete structures is analogous to 'cancer' in humans and costs about 5 % of GDP. Galvanic cathodic protection can stop corrosion of steel, extend the service life, and reduce the carbon footprint and life cycle cost of concrete structures. This study will aim to make galvanic anodes with a zinc piece encapsulated in a special mortar with interconnected pores, activators, and humectants. We are looking for passionate students who can perform analytical and experimental studies on the cement chemistry of mortar, electrochemistry/corrosion of zinc in mortar, time-variant clogging and evolution of pore structure of mortar, simultaneous transport of zinc corrosion products and various ions through porous mortar. Students with good background in either civil engineering, material science, or applied mechanics can apply.

Encapsulating mortar
Zinc disc
Tie-wires

○ Zinc corrosion products
● Ions in encapsulating mortar

Faculty advisor
Dr. Radhakrishna G Pillai