IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	Development of a Digital Twin Framework for Forecasting, Monitoring, and Improving Construction Quality in EPC Infrastructure Projects	
Project Number	**IMURA1298**	
Monash Main Supervisor (Name, Email Id, Phone)	A/Professor Mehrdad Arashpour Mehrdad.Arashpour@monash.edu	*Full name, Email*
Monash Co-supervisor(s) (Name, Email Id, Phone)		
Monash Head of Dept/Centre (Name,Email)	Prof. Ha Bui	*Full name, email*
Monash Department:	Department of Civil and Environmental Engineering	
Monash ADGR (Name,Email)	A/Prof. Timothy Scott	*Full name, email*
IITB Main Supervisor (Name, Email Id, Phone)	Prof. Venkata Santosh Kumar Delhi venkatad@iitb.ac.in	*Full name, Email*
IITB Co-supervisor(s) (Name, Email Id, Phone)		*Full name, Email*
IITB Head of Dept (Name, Email, Phone)	Prof. Tom V Mathew	*Full name, email*
IITB Department:	Department of Civil Engineering	

Research Clusters:

Research Themes:

Highlight which of the Academy's CLUSTERS this project will address? *(Please nominate JUST **one.** For more information, see www.iitbmonash.org)*		**Highlight which of the Academy's Theme(s) this project will address?** *(Feel free to nominate more than one. For more information, see www.iitbmonash.org)*	
1	*Material Science/Engineering (including Nano, Metallurgy)*	***1***	*Artificial Intelligence and Advanced Computational Modelling*
2	*Energy, Green Chem, Chemistry, Catalysis, Reaction Eng*	2	*Circular Economy*
3	*Math, CFD, Modelling, Manufacturing*	3	*Clean Energy*
4	*CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control*	4	*Health Sciences*
5	*Earth Sciences and Civil Engineering (Geo, Water, Climate)*	5	*Smart Materials*
6	*Bio, Stem Cells, Bio Chem, Pharma, Food*	6	*Sustainable Societies*
7	*Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng*	7	*Infrastructure*
8	*HSS, Design, Management*		

The research problem

Define the problem

Construction projects face persistent challenges in ensuring quality during the execution phase, especially for irreversible works such as concrete foundations, tower footings, and prestressed elements. Deviations in critical parameters like water–cement ratio, curing conditions, and reinforcement placement often lead to long-term durability issues, safety concerns, and costly rework. Traditional quality control methods—manual inspection, post-facto testing, and compliance audits—are reactive, fragmented, and insufficient for real-time assurance. While current digital solutions focus largely on compliance checking through BIM or documentation, they fall short in actively forecasting and preventing quality failures.

Digital Twin technology offers a new approach by creating a dynamic, real-time virtual replica of construction works, integrating data from BIM, IoT sensors, reality capture, and AI-driven analytics. Such a system can monitor key parameters (e.g., water–cement ratio, curing conditions), predict potential quality failures, and recommend corrective or preventive actions, including repair and retrofitting strategies. Unlike conventional compliance tools, a quality-focused digital twin can embed 4D plan simulation, inspection management, geotechnical and structural integration, and progress tracking into a unified platform, ensuring both proactive quality assurance and improved project delivery.

References

1. Eastman, C., et al., 2011. BIM Handbook. Wiley
2. Sacks, R., et al., 2020. Construction 4.0: Innovation in construction. Routledge.
3. Venkata Santosh Kumar Delhi, et al., IIT Bombay Research on BIM-based compliance checking, AR/VR for construction, and action recognition.
4. Dave, B., et al., 2016. Development of a digital construction platform for production management. Automation in Construction.

Project aims

Define the aims of the project

1. Develop a digital twin framework that ensures real-time quality monitoring in construction, with emphasis on irreversible works like concreting and foundation casting.
2. Create AI/ML models to forecast concrete quality (strength, durability, cracking) based on key parameters such as water–cement ratio, curing, and compaction.
3. Integrate geotechnical and structural models into the digital twin for holistic quality assessment.
4. Embed 4D/5D planning, AR/VR inspection, and automated progress tracking within the twin.
5. Provide predictive insights for preventive measures, repair methodologies, and retrofitting strategies.

How skills/experience of the IITB and the Monash supervisor(s) support the proposed project

Highlight the purpose of the collaboration and/or the complementary skills/experience that you bring to the project. Do you have any joint or independent publications in the area of the proposed project?

What is expected of the student when at IITB and when at Monash?

Highlight how the project will gain from the students stay at IITB and at Monash

Expected outcomes

Highlight the expected outcomes of the project

1. Digital twin framework for real-time quality monitoring and forecasting in EPC projects.
2. AI/ML models to predict concrete strength, durability, and defect risks.
3. Integrated geotechnical–structural assessments for long-term safety
4. 4D/5D simulations, AR/VR inspections, and automated progress tracking for proactive quality assurance.
5. Reduced rework and cost overruns through predictive insights.
6. Decision-support for preventive measures, repair, and retrofitting.
7. Contributions to Construction 4.0 research and scalable industry applications

How will the project address the Goals of the above Themes?

Describe how the project will address the goals of one or more of the 6 Themes listed above.

How well the IITB and the Monash supervisor(s) know each other

Provide details of previous collaborations (if any). For new collaborators, have you had a chance to meet each other in person or through VC or Skype?

Potential RPCs from IITB and Monash

Provide names of the potential research progress committee members (RPCs) and describe why they are most suited for the proposed project

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.

Necessary Courses

Name three tentative courses relevant to the project that the student should complete during his/her coursework at IITB (the student will require to secure 8 point in these courses)

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

K**eywords** relating to this project to make it easier for the students to apply.