Final Year Project Showcase
Batch-2022-2026
Year 2026

	Department: Civil Engineering Programme: Civil Engineering
1	Project Title: Comprehensive Study of GFRP Bar Bond Behavior using Beam End Test **Project Idea** The project investigates the bond-slip response of Glass Fiber Reinforced Polymer (GFRP) bars with concrete to serve as a corrosion-resistant alternative to steel reinforcement. The primary goal is to evaluate the effect of varying development lengths and surface treatments using the beam end test method and to predict bond strength using machine learning models.
2	**Process** The methodology integrated experimental testing and computational modeling. Nine concrete beam end specimens were cast with GFRP bars featuring 5D and 10D development lengths, utilizing both sand-coated and non-coated surfaces. These specimens were tested using a Universal Testing Machine to simulate flexural tensile stresses. Additionally, a database of 1032 data points was compiled from existing literature to train black-box regression algorithms and a white-box symbolic regression model..
3	**Outcome** The experimental testing revealed that sand-coated GFRP bars developed significantly superior bond characteristics compared to standard non-coated bars. The black-box Random Forest machine learning model predicted bond strength with a high accuracy R2 value of 0.90. A new interpretable mathematical equation was also generated using the white-box model, which outperformed existing design code formulas.
4	**Evidence (Theoretical Basis)** Traditional steel reinforcement is highly susceptible to corrosion when exposed to moisture and salts, which compromises structural durability. GFRP is a viable alternative due to its high tensile strength and rust resistance, but its distinct, brittle bond mechanics require thorough evaluation. Prior research predominantly relied on direct pullout tests that do not accurately represent real beam flexure, making the RILEM beam end test a more precise standard for theoretical validation.
5	**Competitive Advantage or Unique Selling Proposition** (Industry, Innovation & Infrastructure and Sustainable Cities & Communities) The project provides a highly accurate graphical user interface for machine learning analysis that significantly improves bond strength prediction capabilities. By replacing the commonly used but less accurate pullout test data with beam end test results, this solution delivers a robust framework for safely integrating GFRP into the construction industry.
a	**Attainment of any SDG** (e.g. How it is achieved and why it is necessary for the region) This study directly supports the goals of Industry, Innovation, and Infrastructure as well as Sustainable Cities and Communities. Achieving these goals is necessary because traditional steel-reinforced structures deteriorate over time, while adopting GFRP creates resilient infrastructure that requires less maintenance.
b	**Any Environmental Aspect** (e.g. carbon reduction, energy-efficient, etc.) Utilizing GFRP in place of steel eliminates the problems of rust and carbonation caused by aggressive environmental conditions. This resistance extends the service life of structures, reducing the need for frequent rebuilding and promoting a more sustainable construction ecosystem.
c	**Cost Reduction of Existing Product** While carbon and aramid fibers possess superior mechanical properties, GFRP is specifically highlighted as the most economically viable and practical choice for civil engineering applications due to its lower raw material cost. Furthermore, better predictive equations will prevent conservative over-designing, optimizing material usage and reducing overall construction expenses
d	**Process Improvement which Leads to Superior Product or Cost Reduction, Efficiency Improvement of the Whole Process** (e.g. What is the issue is current process and what improvement you suggests) Current design code equations from regulatory bodies are overly conservative and frequently underestimate true bond strength. The proposed machine learning approach and newly generated formulas provide a faster

	and more accurate process for predicting bond capacity, allowing engineers to design structural elements much quicker and with greater efficiency.	
e	**Expanding of Market share** (e.g. how it expand and what is the problem with the current market The current construction market heavily relies on steel, which suffers from long-term durability issues. GFRP struggles to capture mainstream market share due to insufficient research on its bond behavior under realistic flexural conditions. Providing reliable and validated equations allows construction firms to confidently adopt GFRP, expanding its market utilization.	
f	**Capture New Market** (e.g. Niche market or unaddressed segment) This research targets construction in highly corrosive environments, such as marine infrastructure or areas exposed to harsh chemicals, where traditional steel fails rapidly. GFRP reinforcement fills this niche segment by offering a lightweight and chemical-resistant alternative for specialized structural applications.	
g	**Any Other Aspect** The study identifies a significant gap in existing literature, noting that 78.3 percent of past research utilized the less accurate pullout test. Very few studies have examined combinations of diverse bar materials and surface treatments, and the proposed tool encourages targeted future research by highlighting these exact data deficiencies.	
6	**Target Market** (Industries, Groups, Individuals, Families, Students, etc) The primary target market includes the civil construction industry, structural engineering design firms, and material testing laboratories. It also serves academic researchers, engineering students, and code-developing organizations seeking to update design manuals with more accurate bond strength parameters.	
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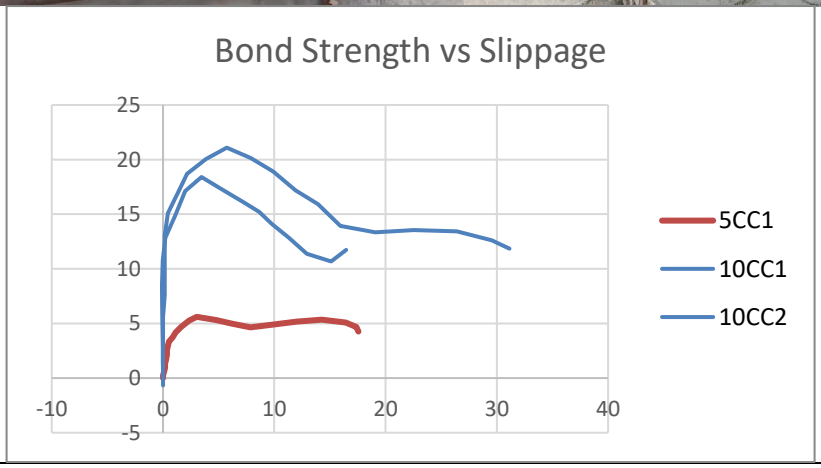
10	**Pictures (If any)**	

11	**Video (If any)**	NA