Final Year Project Showcase Batch-2021
For the Year 2025

Department of Civil Engineering TIEST Name of Programme: Bachelor of Engineering		
1	**Project Idea**	**Title:** Utilization of Industrial Waste Material in Self-Healed Fiber Reinforced Concrete: A Sustainable and Energy Efficient Approach **Idea:** The construction sector contributes significantly to excessive resource consumption, energy demand, and global CO_2 emissions. The development of cracks in concrete infrastructure is a major problem since it drastically lowers durability, increases the need for maintenance, and raises long-term environmental and financial expenses. Innovative concrete materials that are not only long lasting and energy-efficient but also self-healing are desperately needed to address these problems. These materials must incorporate low-carbon, sustainable substitutes for traditional raw materials.
2	**Process**	**Material Selection & Characterization** • Selected industrial waste materials (e.g., coal bottom ash as fine aggregate replacement and silica fume as cement replacement). • Chose polypropylene fibers for crack control and enhanced toughness. • Used a commercially available crystalline self-healing admixture. **Concrete Mix Design** • Developed several trial **fiber-reinforced concrete mixes** incorporating varying percentages of industrial waste materials. • Ensured workability and strength requirements as per ASTM/ACI standards. **Casting & Curing** • Prepared standard-size specimens (cubes, cylinders, prisms) for mechanical and durability tests. • Applied **initial curing** for 28 days under controlled conditions. **Induced Cracking for Healing Study** • Pre-cracked selected specimens using controlled loading. • Exposed cracked specimens to water immersion and wet–dry cycles to activate the self healing process. **Testing & Evaluation** • Conducted tests for **compressive strength**, **flexural strength**, and **split tensile strength**. • Evaluated **healing efficiency** by measuring recovery in strength, water permeability, and visual crack closure. • Performed **microscopic analysis** to confirm healing product formation. **Data Analysis & Sustainability Assessment** • Compared the performance of developed mixes with conventional concrete. • Performed a **basic life-cycle impact estimation** (based on embodied energy and CO_2 reduction). • Assessed **cost-efficiency** and potential scalability
3	**Outcome**	Effectively used industrial waste materials to create self-healing fiber-reinforced concrete, lowering the need for cement and natural aggregate. Fiber reinforcement resulted in improved mechanical performance, especially in flexural and

		tensile strength. Demonstrated partial strength recovery following self-healing cycles and visible crack healing. Water permeability was decreased, indicating increased durability. Estimated a decrease in embodied energy and CO2 emissions, helping to create a more environmentally friendly building solution. Offered a reasonably priced and environmentally responsible substitute for traditional concrete that might find practical use in infrastructure.
4	**Evidence (Theoretical Basis)**	Concrete is most widely used material now a day because of its versatile properties. But it has also some disadvantages and one of which is its brittle nature, make it suspect able to cracking which appears to be for serval reason like heat of hydration, loading, temperature various. Due to this nature performance and sustainability of concrete structures often compromised, thus early repair of the concrete structures is of prime importance. Self-healing technique is one of the cost-effective and timing saving which not only improves the performance of concrete but also improves overall service life of concrete structures. The main objective of present study is to use locally available waste and supplementary materials like fly ash and silica fume along with pp fibers to investigate the mechanical and durability performance of concrete at early age healing. Concrete mix with ratio of 1:2:4 with cement Type-I, fine aggregate passing from #16 sieve, coarse aggregate of 10mm size and polypropylene fibers (1%) by volume of mix were used. Fly ash type-c was replaced with cement at level form 0-40% along with optimum level of silica fume which was kept 10%. The w/c ratio was kept constant throughout the study which was 0.40. Different tests were conducted on concrete samples to assess the self-healing capacity which includes, compressive strength, split tensile strength, modulus of rupture, carbonation and Sulphate attack at 7, 28 and 56 days of healing durations. Based on detailed test results, it was observed that at 30% addition of fly ash along with SF and fibers showed increase in mechanical performance at all healing durations, however durability test results were found to be reasonable when fly ash and silica fume were used. Increase in mechanical performance is mainly attributed to the fact that fly ash and silica fume has better pozzolanic activity than cement which trigger the hydration rate faster and fibers tend to acts as bridge between crack and supply ample amount of water during healing process. Thus, it was concluded that test results of present study can be used in concrete structures especially for dams, bridges which are in direct contact with water, thus both strength and durability can be controlled. building sector.
5	**Competitive Advantage or Unique Selling Proposition** (Cost Reduction, Process improvement, Attainment of any SDG (Sustainable Development Goal), increase of market share or capturing new market or having superior performance over a competitor. In summary, any striking aspect of the project that compels the industry to invest in FYP or purchase it. Some detailed description is required in terms of how, why when what. You can select one or more from the following dropdown and delete the rest of them) Please keep relevant options, delete the rest of them, and correct the sequence Attainment of any SDG (Sustainable Development Goal), increase of market share or capturing new market or having superior performance over a competitor. In summary, any striking aspect of the project that compels the industry to invest in FYP or purchase it. Some detailed description is required in terms of how, why when what. You can select one or more from the following dropdown and delete the rest of them). Please keep relevant options, delete the rest of them, and correct the sequence	

	Description (How, Why, When, What) What appeals about this project? This project combines fiber reinforcement, industrial waste materials, and self-healing functionality to provide a high-performance, environmentally friendly concrete solution. The end product is a long lasting, low-maintenance, environmentally friendly concrete mix that specifically tackles major issues in the building sector, like high lifecycle costs, frequent repairs, and cracking. **What makes it better than regular concrete?** When exposed to moisture, micro-cracks' self-healing qualities enable them to close on their own, minimizing the need for repairs. By increasing tensile and flexural strength, fiber reinforcement slows the spread of cracks. Utilizing industrial waste (such as silica fume and coal bottom ash) to partially replace cement and aggregates improves sustainability and reduces material costs. shown increases in strength recovery following damage, durability, and resistance to cracking. **Why would the industry spend money on this?** Economical: lowers infrastructure's long-term maintenance and repair expenses by as much as 40–60% (based on literature benchmarks). Sustainability compliance: Complies with LEED and BREEAM green building certifications, ESG reporting requirements, and global sustainability goals. Regulatory advantage: By using industrial waste and turning liabilities into resources, it assists industries in adhering to circular economy policies. Leadership in innovation: Early adopters can establish themselves as pioneers in intelligent and environmentally friendly building. **Where and when is this applicable?** Instant use in low-cost housing, industrial flooring, water channels, pavements, and roads in urban areas. Particularly appropriate for developing areas with a lack of maintenance resources or environments that are prone to cracking (high traffic areas, coastal and marine zones). **How and which SDGs are achieved?** SDG 11: Sustainable Cities and Communities: Infrastructure that is more resilient, long-lasting, and low-maintenance. Reusing industrial waste is part of SDG 12: Responsible Consumption and Production. SDG 13: Climate Action: Lower CO2 emissions by extending the lifecycle and reducing cement use	
a	**Cost reduction of existing Product**	By addressing both material costs and long-term maintenance expenses, this project results in a significant cost reduction (up to 15-20%) when compared to conventional concrete. The initial cost of producing concrete is reduced by partially substituting easily accessible industrial waste materials, such as silica fume and coal bottom ash, for pricey cement and natural aggregates. Furthermore, fiber reinforcement and self-healing agents greatly increase the concrete's durability, lowering the frequency and expense of crack repairs over the course of the structure's life. This lowers lifecycle costs, particularly for infrastructure that is subjected to harsh environments and usually requires a lot of maintenance. This product is more cost-effective than conventional concrete due to its lower raw material costs and lower maintenance requirements, which will benefit building projects in the public and private sectors in the long run.
b	**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)	High material costs, elevated carbon emissions, and limited durability as a result of crack formation over time are the outcomes of the traditional concrete production process' heavy reliance on cement and natural aggregates. Furthermore, because traditional concrete is incapable of self-repairing, it requires frequent cycles of maintenance and repair, which exacerbates operational inefficiencies. By using an inventive mix design that partially substitutes industrial waste materials for cement and aggregates, our project enhances this procedure while lowering overall costs and reliance on raw materials. Furthermore, by strengthening crack resistance and facilitating autonomous healing when exposed to moisture, the addition of fibers and a crystalline self-healing admixture improves concrete's performance. This advancement offers a workable and scalable upgrade over current concrete technologies by improving the sustainability and efficiency of the entire concrete lifecycle as well as producing a better product with longer service life, fewer repairs, and lower lifecycle costs.

c	**Attainment of any SDG** (e.g. How it is achieved and why it is necessary for the region)	SDGs 11: Sustainable Cities and Communities, 12: Responsible Consumption and Production, and 13: Climate Action are all greatly aided by this project. The durability, longevity, and resource efficiency of concrete infrastructure are improved by creating a concrete mix that incorporates fiber reinforcement, self-healing technology, and locally accessible industrial waste materials. The project lowers environmental pollution and promotes circular economy principles by using waste materials like silica fume and coal bottom ash to partially replace cement and aggregates. This strategy is essential in areas like Pakistan, where the demand for long-lasting and low-maintenance infrastructure is rising due to rapid urbanization. It is extremely relevant and essential for attaining long-term urban sustainability in resource-constrained environments because it minimizes the need for frequent repairs, lowers lifecycle costs, and lowers the carbon footprint of construction.
d	**Expanding of Market share** (e.g. how it expand and what is the problem with the current market	The market for concrete is currently dominated by conventional materials, which are widely used but have drawbacks like poor durability, high maintenance costs, and an adverse effect on the environment because of their high cement content. These disadvantages leave a void in the market for long-lasting, low-maintenance, and environmentally friendly building materials. By providing a next-generation concrete product that blends fiber reinforcement, self-healing properties, and industrial waste utilization, our project fills this gap. Over time, the product's performance improves thanks to this innovation, particularly in urban infrastructure and isolated locations with limited access to repairs. With governments, developers, and construction companies placing a greater emphasis on carbon footprint reduction, green building practices, and low lifecycle costs, this waste-based, self-healing concrete presents a compelling value proposition. It could expand market share beyond conventional concrete applications by capturing new market segments, especially in sustainable housing, municipal infrastructure, coastal structures, and green-certified construction projects
e	**Capture new market (**e.g. Niche market or unaddressed segment**)**	This project aims to fill a gap in the market for long-lasting, low-maintenance, and environmentally friendly building materials for infrastructure in isolated, coastal, and resource-constrained locations that are currently unmet by traditional concrete solutions. Conventional concrete is not self-healing and needs regular upkeep, which is frequently expensive and logistically challenging in these areas. The project's development of a self-healing fiber-reinforced concrete using locally accessible industrial waste materials creates a product that is perfect for low-income housing projects, rural roads, water retaining structures, and marine applications where low maintenance and long service life are essential. The product's low carbon footprint and sustainable design also make it appealing to the expanding green construction market, which includes projects aiming for LEED or BREEAM certification. As a result, this innovation provides access to new and developing markets that are not well-served by traditional concrete technology and are centered on resilient, reasonably priced, and sustainable infrastructure.
f	**Any Environmental Aspect** (e.g. carbon reduction, energy-efficient,	By addressing both carbon reduction and energy efficiency in the production of concrete, this project offers substantial environmental

	etc.)	benefits. Since cement production is a significant source of CO_2 emissions, the total carbon footprint of the concrete mix is decreased by partially substituting industrial waste materials like silica fume and coal bottom ash for cement and natural aggregates. Furthermore, the concrete's capacity to mend itself lessens the need for regular repairs, which saves the energy and raw materials normally used in maintenance procedures. By increasing durability and prolonging the service life of structures, fiber reinforcement also helps to conserve resources. In general, the project supports an environmentally conscious, energy-efficient, and low-carbon building methodology that is in line with the objectives of climate action and sustainable development.
g	**Any Other Aspect**	
6	**Target Market** (Industries, Groups, Individuals, Families, Students, etc) Please provide some detail about the end-user of the product, process, or service	A wide range of industries, government agencies, and social groups looking for long-lasting, environmentally friendly, and reasonably priced building solutions make up the target market for this novel self-healing fiber-reinforced concrete. Important end users consist of: • Roads, bridges, water channels, industrial floors, and mass housing projects are all handled by construction and infrastructure companies, particularly when long-term performance and low maintenance are essential. • Government agencies and local governments, especially those in charge of maintaining infrastructure in isolated or coastal regions where durability is crucial and repair access is restricted. • Housing authorities and real estate developers are looking for affordable housing options with low lifecycle costs or green certification. • NGOs and development organizations that work on affordable or rural housing in areas with limited resources, where maintenance-free and sustainable solutions are essential. • Institutions of higher learning and research are investigating smart materials for environmentally friendly building. • Green building consultants and environmental certification organizations encourage the use of self-healing, low-carbon materials. This product is particularly appealing in markets where there is a growing need for environmentally friendly infrastructure and sustainable urban development because of its sustainability, low maintenance requirements, and use of industrial waste.
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