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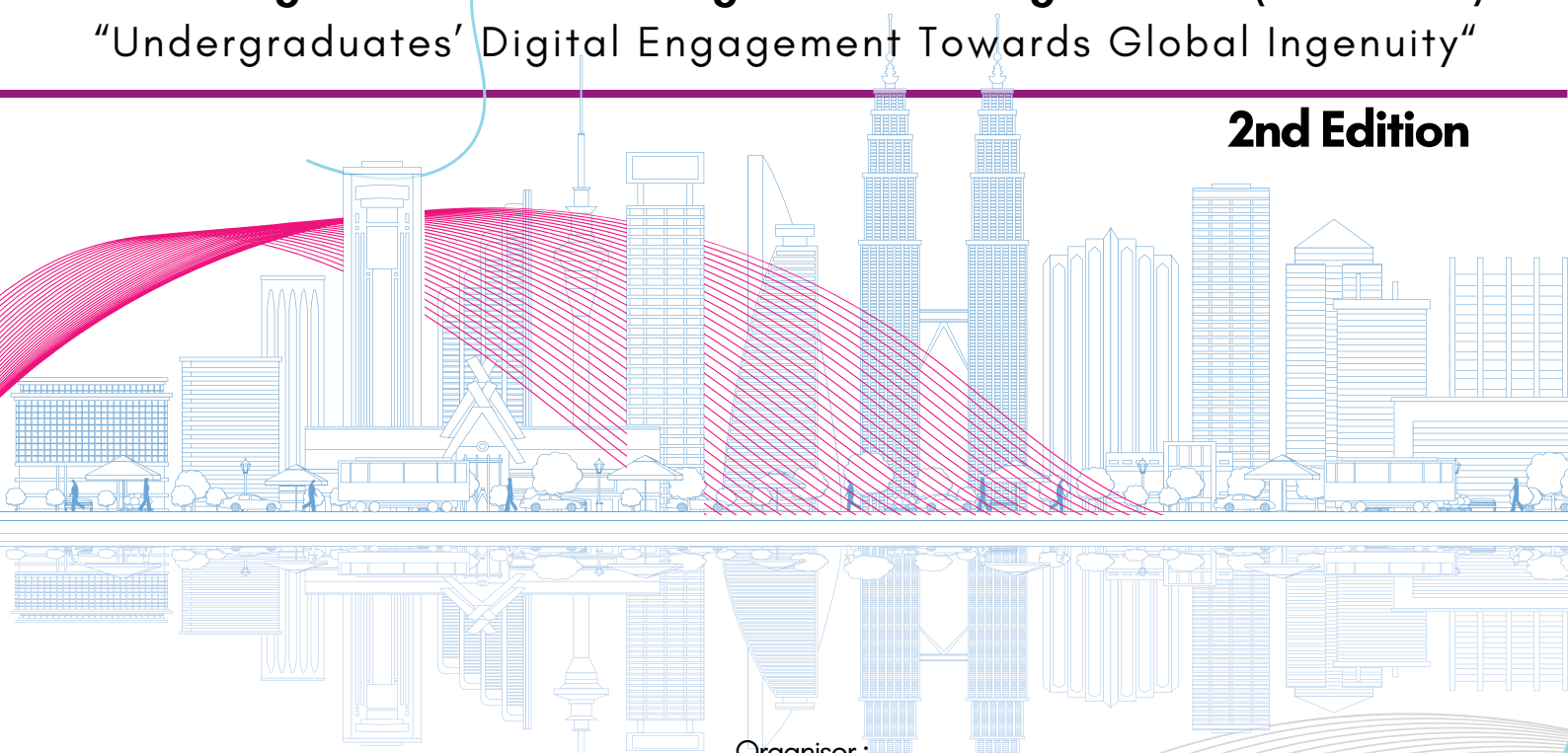
"Undergraduates' Digital Engagement Towards Global Ingenuity"

2nd Edition



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Co-organiser :

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UTILISATION OF EGGSHELLS FOR PREVENTING CRACK IN PRECAST CONCRETE COMPONENTS

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Abstract
The use of eggshells in preventing cracks in precast concrete components offers a new and eco-friendly solution to an age-old problem. Cracks in concrete can compromise the strength and durability of structures, leading to costly repairs and safety concerns. This project explores how eggshells can be used as a self-healing material in precast concrete to enhance its longevity and sustainability. Our goals are to understand the current challenges in crack prevention, develop a way to mix eggshells into concrete, and test this method in both the lab and real-world conditions. The research combines an extensive review of existing studies with hands-on experiments. We hope to show that eggshells can significantly improve the performance of precast concrete, making it a more durable and environmentally friendly building material.

Keywords: *Crack prevention, eggshells, precast concrete, self-healing, sustainable construction*

1. INTRODUCTION

This innovation project integrates eggshell fragments into precast concrete to enhance structural integrity and sustainability. Eggshells, primarily composed of calcium carbonate, improve concrete's compressive strength and durability, reducing reliance on cement and repurposing waste materials. This approach addresses issues like cracking and early deterioration, extending the lifespan of buildings and infrastructure while supporting sustainable construction practices. By incorporating eggshells, the project aligns with circular economy principles, emphasising resource efficiency and waste reduction, ultimately contributing to more resilient and durable infrastructure.The project seeks to utilise eggshells as a self-healing agent in precast concrete, focusing on the cracking issues in Industrialised Building Systems (IBS). Testing at various intervals will evaluate the effectiveness of this self-healing mechanism. The initiative represents a shift towards technology-driven solutions, potentially reducing structural flaws, environmental impact, and repair costs. The scope includes developing a method for incorporating eggshells into the concrete mix and evaluating their effectiveness through experiments and simulations. This innovative approach aligns with Sustainable Development Goals, promoting sustainable resource management and enhancing the durability and longevity of precast concrete components.

2. LITERATURE REVIEW

Cracking in concrete refers to the separation of the material into segments due to breaking or fracturing, often compromising structural integrity (Nidhi et al., 2021). Various factors such as moisture movement, thermal expansion, elastic deformation, creep, chemical reactions, and foundation movement contribute to cracking (Chitte & Chetan, 2018). These cracks, categorised as structural or non-structural, can arise from design flaws, inadequate site surveys, or internally induced stresses. Structural cracks jeopardise safety, while non-structural ones may cause aesthetic issues (Suffian, 2013).

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Regular inspections are crucial to maintaining the integrity and serviceability of buildings (Sakib, 2015). Untreated cracks allow moisture penetration, accelerating degradation and posing serious risks to structural safety (Pise et al., 2021).

Research indicates that structural defects, including cracks, significantly impact the mental well-being of occupants (Andrews et al., 2023). The study by Sabnis (1998) highlights the importance of understanding material properties, mix design, curing conditions, and other factors to prevent and mitigate cracks, ensuring the longevity of concrete structures. Addressing cracks promptly is essential for preserving the safety, durability, and visual appeal of buildings. The integration of eggshell powder (ESP) into concrete shows promise in enhancing compressive, flexural, and tensile strengths, contributing to sustainable construction practices. ESP, primarily composed of calcium carbonate, can improve concrete properties when used with pozzolanic materials (Hamada et al., 2020). Utilising ESP aligns with sustainable development goals by promoting resource efficiency and reducing the environmental impact of concrete production (Murthi et al., 2022).

3. METHODOLOGY

Research methodology is a systematic framework used to solve research problems methodically (Purwanto, 2023). It includes selecting research methods, collecting data, and achieving reliable results through a structured blueprint. The main elements of research methodology are the research process, research design, data collection methods, and data analysis. The research process involves reviewing literature, formulating research questions or hypotheses, designing the study, collecting, and analysing data, and interpreting findings to contribute to knowledge in a particular field (Henryk, 2020).The innovation project methodology centres on a qualitative approach to enhance the sustainability and functionality of precast concrete components. This methodology involves several key stages, beginning with a comprehensive desk study. Document analysis is utilised to examine a wide range of sources, including books, academic journals, newspaper articles, and institutional reports. This method allows for a thorough understanding of existing knowledge and practices related to the use of concrete and eggshell waste. The insights gained from this analysis inform the development of the project's theoretical framework, ensuring that the research is grounded in established literature while identifying gaps that the project aims to address.

Following the desk study, the methodology progresses to the creation and testing of prototypes. This stage involves determining the optimal combination ratios of raw materials, specifically concrete waste and eggshell waste, and implementing casting and curing procedures. The prototypes serve as practical applications of the theoretical concepts explored during the desk study, bridging the gap between abstract ideas and empirical evidence. By experimenting with these prototypes, the research evaluates the feasibility and effectiveness of using eggshell waste in concrete mixtures. This iterative process of assembling, mix design, experimentation, and data analysis ensures that the innovation project not only advances theoretical understanding but also provides practical solutions for sustainable construction practices.

4. RESULTS AND DISCUSSION

This innovation project on incorporating eggshells into precast concrete highlights a significant advancement in sustainable construction materials, offering a comprehensive comparison with existing concrete products. By evaluating material properties, environmental impact, and cost-effectiveness, the project demonstrates the enhanced mechanical properties, sustainability, and marketability of eggshell-infused concrete.

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Testing results, including Ultrasonic Pulse Velocity (UPV), compressive strength, and water density tests, validate the performance of this innovative material, showcasing its improved structural integrity and potential for commercial viability in the construction industry.

Detailed analyses reveal that eggshell inclusion significantly enhances concrete's structural properties and environmental sustainability. The UPV and compressive strength tests indicate that eggshell content improves crack resistance and overall durability, with the optimal performance observed at 3% eggshell content. Water density tests further corroborate these findings, demonstrating that eggshell-infused concrete exhibits favourable hydration and porosity characteristics. These results collectively suggest that eggshell-incorporated concrete can outperform traditional concrete and other innovative alternatives like POFA and banana fibre in terms of crack resistance, strength, and eco-friendliness.

Figure.1 Precast Concrete Cube Sample with Eggshell Implementation

The marketability potential of eggshell-infused concrete is promising due to its environmental benefits, cost-effectiveness, and superior performance. Eggshells, an abundant waste product, can reduce raw material costs and align with green building certifications. The concrete's enhanced strength, durability, and lighter weight facilitate easier transportation and installation, making it suitable for a range of construction applications. Effective stakeholder education, strategic marketing, and partnerships are essential for widespread adoption, with ongoing research necessary to refine the material and explore additional benefits. Overall, eggshell-infused concrete presents a viable and sustainable solution for modern construction challenges. In this innovative project, the use of eggshell powder as a partial cement replacement in precast concrete was explored to enhance both sustainability and performance.

The study involved testing three different concrete mixes: a control mix with no eggshell, a mix with 3% eggshell powder, and a mix with 6% eggshell powder. Key tests, including compressive strength, water density, and Ultrasonic Pulse Velocity (UPV), were conducted to evaluate the properties of the concrete. The UPV test was particularly valuable for assessing crack resistance. Results revealed that the 6% eggshell mix showed the highest density and minimal cracking, indicating superior durability and structural integrity. In contrast, the control and 3% eggshell mixes exhibited more significant crack development over time, with the 3% mix showing improvement over the control but still less effective than the 6% mix. Overall, incorporating eggshell powder, especially at a 6% concentration, proved

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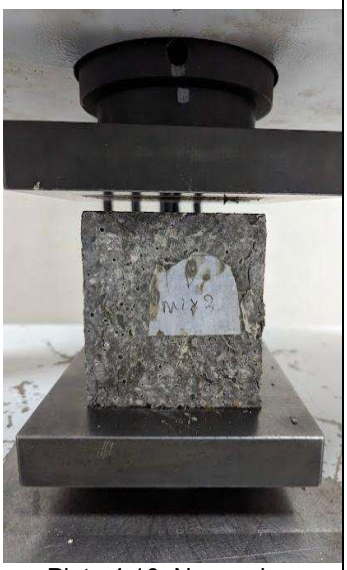
to enhance concrete's performance by reducing crack formation and improving long-term durability.

Table 1. Cracks Observation for sample for 38 Days

Mix 1, Traditional Precast (0% of Eggshell)	Mix 2 (3% of Eggshell)	Mix 3 (6% of Eggshell)
 Plate 4.8: Obvious cracks	 Plate 4.9: Improved cracks	 Plate 4.10: No cracks

5. CONCLUSION

This innovation project demonstrates the potentials of using eggshells as a self-healing agent in precast concrete to address critical issues in construction. By leveraging the calcium carbonate in eggshells, the project successfully enhances concrete's durability and sustainability. The study revealed that concrete samples with eggshell powder showed up to a 50% reduction in crack width compared to control samples, thanks to the formation of calcium carbonate crystals that seal cracks. This method not only provides a solution to waste management but also aligns with sustainable development goals and national policies promoting environmental protection and technological advancement. The project's findings underscore the promise of integrating eggshells into concrete to improve material performance and reduce the environmental impact of construction.

6. ACKNOWLEDGMENT

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