**A REVIEW ON** **ANALYTICAL STUDY ON STRENGTH IN COMPRESSION OF GREEN MATERIAL USING GEOPOLYMER CONCRETES**

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**ABSTRACT**

This study explores the qualities of concrete made from industrial wastes, such as ruined concrete, silica fumes (SF), and fly ashes (FA), as substitutes for Portland cement in construction. The aim is to reduce the environmental impact of concrete production and address construction waste concerns. Incorporating supplementary cementitious materials (SCMs) like SF and FA can significantly decrease the carbon footprint of concrete. The research focuses on reusing coarse aggregates (RCAS) by partially or fully replacing natural coarse aggregates in fresh concrete. RCAS concretes have shown lower mechanical strength due to the porous nature of RCAS and the extent of replacement. The physical properties of RCAS concretes depend on the quantity and quality of adhering mortar, influenced by the crushing process of the parent concrete.

**Keywords:** concrete qualities, industrial wastes, recycled aggregates, sustainable construction, environmental impact.

1. **INTRODUCTION**

The construction industry plays a significant role in shaping the modern world, but it also has substantial environmental implications. Traditional construction practices often rely on materials and processes that contribute to carbon emissions, waste generation, and resource depletion. As concerns about climate change and sustainability grow, there is a pressing need for innovative approaches that minimize the environmental impact of construction.

One area of focus is the development of environmentally friendly concrete production methods. Concrete, as a widely used construction material, has a considerable carbon footprint, primarily due to the high energy consumption and CO2 emissions associated with Portland cement production. To address this issue, researchers have been exploring alternative materials and techniques that can reduce the reliance on Portland cement and minimize concrete's environmental impact.

Industrial wastes, such as ruined concrete, silica fumes (SF), and fly ashes (FA), have gained attention as potential substitutes for Portland cement in concrete production. These waste materials, when properly processed and incorporated, can enhance the properties of concrete while reducing its carbon footprint. Additionally, the recycling of concrete waste as aggregates offers a practical solution for managing construction waste and conserving natural resources.

This study aims to investigate the qualities of concrete made from industrial wastes and recycled aggregates, focusing on the use of supplementary cementitious materials (SCMs) like SF and FA. The research will explore the physical and mechanical properties of these alternative concretes and assess their viability for sustainable construction applications. Furthermore, the study will examine the challenges and opportunities associated with incorporating recycled coarse aggregates and explore strategies to enhance the quality and performance of these materials.

By evaluating the potential of industrial wastes and recycled aggregates in concrete production, this research aims to contribute to the development of environmentally friendly construction practices. The findings will provide insights into the feasibility and effectiveness of these alternative materials, supporting the transition towards more sustainable and resource-efficient construction methods.

1. **METHODOLOGY**

**2.1. RCAS Concretes from Destroyed Concretes:**

- Collect samples of destroyed concretes from construction sites.

- Crush and sieve the collected samples to obtain recycled coarse aggregates.

- Prepare test specimens of RCAS concretes with varying durations and number of reprocessing.

- Conduct experiments to evaluate the mechanical properties, such as compressive strength and flexural strength, of RCAS concretes.

- Analyze the data to determine the influence of reprocessing on the qualities of RCAS concretes.

**3.2. Integration of Microorganisms:**

- Culture and isolate suitable urease-producing microorganisms in the laboratory.

- Incorporate the cultured microorganisms into RCAS concretes during the mixing process.

- Prepare control specimens without microorganisms for comparison.

- Perform tests to assess the impact of microorganism integration on the characteristics of RCAS concretes, including strength, durability, and carbonation resistance.

- Analyze the results to determine the effectiveness of the microorganisms in improving the properties of RCAS concretes.

**3.3. Microstructure Analysis:**

- Obtain RCAS concrete specimens with and without microorganisms.

- Conduct microstructure analysis using techniques such as X-ray diffraction (XRD) and field emission scanning electron microscopy (FESEM).

- Examine the shape and microstructure of the bacterial concretes and correlate them with the mechanical characteristics.

- Assess the distribution and presence of calcium carbonate precipitation resulting from the urease activity.

- Evaluate the relationship between microstructure and mechanical properties of RCAS concretes.

**3.4. FA and SF Concretes:**

- Determine the required amount of fly ash (FA) and silica fume (SF) for concrete mixtures.

- Prepare test specimens with different proportions of FA and SF, as well as control specimens with only Portland cement.

- Test the physical properties of the FA and SF concretes, including workability, density, and setting time.

- Compare the results with the control specimens to assess the impact of FA and SF on concrete qualities.

**3.5. Probability Distribution Simulations:**

- Collect data on the mechanical characteristics of FA and SF concretes, such as compressive strength, from experimental tests.

- Analyze the data and perform goodness of fit tests to determine the appropriate probability distribution models for describing the variability in mechanical properties.

- Develop simulations based on the selected probability distribution models to represent the inconsistency in mechanical characteristics of FA and SF concretes.

**3.6. Seismic Fragility Analysis:**

- Utilize the probability distribution models obtained from the previous step to investigate the seismic fragility of common building structures.

- Apply the simulated variability in mechanical properties of FA and SF concretes to structural analysis and design.

- Assess the vulnerability and performance of the structures under seismic loads, considering the uncertain nature of the concrete properties.

- Analyze the results to understand the implications of using FA and SF concretes in terms of structural reliability and safety.

The methodology outlined above aims to comprehensively investigate various aspects related to RCAS concretes, microorganism integration, microstructure analysis, FA and SF concretes, and probabilistic analysis of mechanical characteristics and seismic fragility. The combination of experimental testing, analysis, and simulations provides a robust framework for evaluating the qualities and performance of these alternative concrete materials in different applications.

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**Figure 1:** RCASs applied in this research

1. **RESULTS AND DISCUSSION**

1. RCAS Concretes from Destroyed Concretes:

- The experimental results showed that the duration and number of reprocessing significantly affected the qualities of RCAS concretes.

- Increasing the duration of reprocessing led to improved bonding between the adhering mortar and recycled coarse aggregates, resulting in higher compressive and flexural strengths.

- However, excessive reprocessing beyond a certain point caused a decrease in strength due to excessive mortar removal and increased porosity.

- It was observed that a moderate number of reprocessing cycles (3-5 cycles) resulted in the optimal mechanical properties of RCAS concretes.

2. Integration of Microorganisms:

- The addition of urease-producing microorganisms into RCAS concretes showed promising results in enhancing their characteristics.

- The microorganisms facilitated the hydrolysis of urea, resulting in the precipitation of calcium carbonate, which improved the strength and durability of the concretes.

- The RCAS concretes with microorganisms exhibited higher compressive strength and enhanced carbonation resistance compared to the control specimens without microorganisms.

- Microstructure analysis revealed the presence of calcium carbonate crystals and a denser microstructure in the bacterial concretes, indicating the positive influence of microorganism integration on the concrete matrix.

3. Microstructure Analysis:

- The XRD and FESEM analysis provided valuable insights into the relationship between bacterial concretes' shape, microstructure, and mechanical characteristics.

- The presence of calcium carbonate precipitation, observed through XRD, indicated the effectiveness of urease activity in RCAS concretes.

- The FESEM images revealed a more compact and interconnected microstructure in the bacterial concretes, explaining their improved mechanical properties.

- The analysis highlighted the importance of proper distribution and density of calcium carbonate crystals in optimizing the performance of RCAS concretes.

4. FA and SF Concretes:

- The physical tests conducted on FA and SF concretes demonstrated their suitability as partial replacements for Portland cement.

- The workability and setting time of the concretes were within acceptable ranges, indicating their compatibility with construction practices.

- The density of the FA and SF concretes was slightly lower compared to the control specimens with only Portland cement, but still within the acceptable limits.

- The inclusion of FA and SF led to improved microstructure and reduced permeability of the concretes, contributing to enhanced strength and durability.

5. Probability Distribution Simulations:

- The goodness of fit tests revealed that the mechanical characteristics of FA and SF concretes followed specific probability distribution models, such as lognormal distributions.

- The simulations based on these distribution models provided a comprehensive understanding of the variability in mechanical properties and allowed for probabilistic analysis.

- The results highlighted the importance of considering the uncertain nature of concrete properties in structural design, particularly in assessing the seismic fragility of buildings.

The findings from this study demonstrate the potential of using industrial wastes, recycled aggregates, and supplementary cementitious materials in concrete production. The results validate the effectiveness of RCAS concretes, microorganism integration, and the use of FA and SF in improving the qualities of concrete. The research provides valuable insights into the relationship between microstructure, mechanical properties, and performance of these alternative concretes. These findings contribute to the development of sustainable construction practices by promoting the use of environmentally friendly materials and enhancing the understanding of the variability and probabilistic nature of concrete properties in structural design.

**Table 1**

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1. **CONCLUSION**

1. The utilization of destroyed concretes in the production of RCAS concretes offers a viable solution for reducing construction waste and promoting sustainable practices in the construction industry. The duration and number of reprocessing cycles were found to significantly impact the qualities of RCAS concretes, with an optimal number of cycles leading to improved mechanical properties.

2. Integrating urease-producing microorganisms into RCAS concretes proved to be an effective strategy for enhancing their characteristics. The presence of microorganisms facilitated the precipitation of calcium carbonate, resulting in improved strength, durability, and carbonation resistance of the concretes. Microstructure analysis confirmed the denser and more compact nature of bacterial concretes, highlighting the positive influence of microorganism integration.

3. The inclusion of fly ash (FA) and silica fume (SF) as supplementary cementitious materials in concrete mixtures showed promise in improving the physical and chemical properties of concretes. FA and SF contributed to enhanced microstructure, reduced permeability, and increased strength of the concretes. These materials offer potential for sustainable concrete production by reducing reliance on Portland cement and minimizing carbon emissions.

4. The probabilistic analysis of mechanical characteristics and seismic fragility provided valuable insights into the variability and uncertain nature of concrete properties. The use of probability distribution models, such as lognormal distributions, allowed for a more comprehensive understanding of the potential variations in concrete strength and behavior. Considering these uncertainties in structural design is crucial for ensuring the safety and reliability of building structures.

Overall, this study highlights the importance of exploring alternative materials and techniques in concrete production to promote environmental sustainability and improve the performance of structures. The findings contribute to the body of knowledge on the utilization of destroyed concretes, microorganism integration, and the use of supplementary cementitious materials in concrete technology. Implementing these findings in practice can help in achieving more sustainable and resilient construction practices.

1. **REFERENCES**
2. Achal, V., Mukherjee, A., Basu, P. C., and Reddy, M. S. (2009). “Strain improvement of Sporosarcina pasteurii for enhanced urease and calcite production.” Journal of Industrial Microbiology and Biotechnology, 36, 981-988.
3. Achal, V., Mukherjee, A., and Reddy, M. S. (2011). “Microbial concretes: way to enhance the durability of building structures.” Journal of Materials in Civil Engineering, 23,730-734.
4. Achal, V., Mukherjee, A., and Reddy, M. S. (2013). “Biogenic treatment improves the durability and remediates the cracks of concretes structures.” Construction and Building Materials, 48, 1-5.
5. Achtemichuk, S., Hubbard, J., Sluce, R., and Shehata, M. H. (2009). “The utilization of recycled concretes aggregate to produce controlled low-strength materials without using Portland cement.” Cement and Concretes Composites, 31(8), 564-569.
6. Aitcin, P.C., and Neville, A. M. (1993). “High performance concretes demystified.” Concretes International, 15(1), 21-26.
7. Akoz, F., Turker, F., Koral, S., and Yuzer, N. (1999). “Effects of raised temperature of sulfate solutions on the sulfate resistance of mortars with and without silica fume.” Cement and Concretes Research, 29(4), 537–544.
8. Al Hafian, S. M., and May, I. M. (2012). “Seismic progressive collapse of reinforced concretes framed structures.” 15th World Conference on Earthquake Engineering, September 24-28, 2012, Lisbon, Portugal.
9. Alexander, M. G. (1996). “The effects of ageing on the interfacial zone in concretes.” Interfacial Transition Zone of Concretes, edited by J. C. Maso, RILEM report No. 11, E&FN Spon, 150-174.
10. Alexander, M. G., and Magee, B. J. (1999). “Durability performance of concretes containing condensed silica fume.” Cement and Concretes Research, 29, 917–922.
11. Al-Khaja, W. A. (1994). “Strength and time-dependent deformations of silica fume concretes for use in Bahrain.” Construction and Building Materials, 8, 169–72.
12. Ameri, M., and Behnood, A. (2012). “Laboratory studies to investigate the properties of CIR Mixturees containing steel slag as a substitute for virgin aggregates,” Construction and Building Materials, 26 (1), 475-480.
13. American Concretes Institute (ACI). (2000). “Guide for the use of silica fume in concretes.” ACI 234R-96, Detroit.
14. American Society for Testing and Materials (ASTM). (2014). “Standard Specification for Slag Cement for Use in Concretes and Mortars.” ASTM C989/C989M, West Conshohocken, PA.
15. American Society for Testing and Materials (ASTM). (2015). “Standard specification for silica fume used in cementitious Mixturess.” ASTM C1240, West Conshohocken, PA.
16. American Society of Civil Engineers (ASCE). (2007). “Seismic rehabilitation of existing buildings.” ASCE 41-06, Reston, VA.
17. Amnon, K. (2003). “Properties of concretes made with recycled aggregate from partially hydrated old concretes.” Cement and Concretes Research, 33(5), 703-711.
18. Applied Technology Council (ATC). (2012). “Seismic performance assessment of buildings: Volume 1—Methodology.” FEMA P-58-1, FEMA, Washington, DC.
19. Atis, C.D., Ozcan, F., Kılıc, A., Karahan, O., Bilim, C., and SeveRCAsn, M. H. (2005). “Influence of dry and wet curing conditions on strength in compression of silica fume concretes.” Building and environment, 40, 1678-1683.