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A Review Paper on Replacement of Cement by Coir and Glass Powder

Dr.Syed Omar Ballari, Narayanam Pranay Dhiraj, Vadthiya Sai Kiran, Nomula Shivani

Professor & Head, Department of Civil Engineering, Guru Nanak Institutions Technical Campus, Ibrahimpatnam,
Telangana, India

U.G. Student, Department of Civil Engineering, Guru Nanak Institutions Technical Campus, Ibrahimpatnam,
Telangana, India

U.G. Student, Department of Civil Engineering, Guru Nanak Institutions Technical Campus, Ibrahimpatnam,
Telangana, India

U.G. Student, Department of Civil Engineering, Guru Nanak Institutions Technical Campus, Ibrahimpatnam,
Telangana, India

ABSTRACT:The construction industry is one of the largest consumers of natural resources, with cement production being a significant contributor to environmental degradation due to its high carbon footprint. To address these concerns, this study investigates the potential of replacing cement with alternative materials, specifically coir fiber and glass powder, in concrete mix design. Coir, a natural fiber derived from coconut husks, is known for its sustainability and biodegradability, while glass powder, a waste material from the recycling industry, is rich in silica and can improve concrete properties. This research explores the mechanical properties, workability, and durability of concrete incorporating varying proportions of coir and glass powder as partial replacements for cement. The results indicate that incorporating coir and glass powder improves the workability of the mix and enhances certain mechanical properties such as tensile strength and durability, with optimal performance observed at specific replacement levels. Furthermore, this combination offers a promising solution for reducing environmental impact by repurposing waste materials and reducing the dependency on traditional cement. The findings suggest that coir and glass powder can be viable alternatives for producing sustainable concrete, offering a pathway toward eco-friendly construction practices.

KEYWORDS:Coirfiber, Glass powder, Cement replacement, Sustainable concrete, Environmental impact, Mechanical properties, Workability, Durability, Waste materials, Eco-friendly construction.

I. INTRODUCTION

The rapid growth of the construction industry has led to a substantial increase in the demand for cement, which is a major contributor to environmental degradation due to its high carbon emissions during production. As the world faces pressing environmental challenges, there is a growing need to find alternative materials to replace cement in concrete production, reducing the ecological footprint of construction activities. In this context, the use of waste and natural materials has gained attention as an eco-friendly solution. Coir, a natural fiber extracted from coconut husks, has shown potential as a sustainable material in the construction industry due to its low cost, availability, and biodegradability. Coir fibers, when incorporated into concrete, have been found to improve the flexibility and crack resistance of the mix, offering benefits in terms of durability and performance. On the other hand, glass powder, a byproduct of recycled glass, is rich in silica and has been recognized for its ability to enhance the strength and workability of concrete. When utilized as a partial replacement for cement, glass powder can contribute to the reduction of waste materials and promote a circular economy by reusing glass waste.

This study explores the combined use of coir and glass powder as partial replacements for cement in concrete. By investigating their individual and synergistic effects on concrete properties such as workability, compressive strength, tensile strength, and durability, the research aims to determine the feasibility of these materials as sustainable alternatives to traditional cement. The successful incorporation of coir and glass powder in concrete could lead to more

environmentally friendly construction practices, reduce the consumption of natural resources, and contribute to waste management efforts.

II. LITERATURE SURVEY

Hawreen et al. (2022) examines the use of coir, a natural fiber from coconut husks, as a reinforcement material in cementitious composites, highlighting its high tensile strength, toughness, and saltwater resistance. Coir offers an eco-friendly and cost-effective alternative to synthetic fibers like polypropylene and steel, improving the mechanical properties of concrete, such as tensile strength and toughness, while reducing brittleness. However, challenges include its absorbent nature, which can reduce workability, and potential issues with drying shrinkage and volumetric changes. The review emphasizes the need for further research on the drying shrinkage, bonding behavior of coir fibers with cementitious materials, and the long-term durability of coir-reinforced concrete. Despite these challenges, coir shows significant promise as a sustainable reinforcement material, offering a path to more environmentally friendly construction practices.

Libo Yan et al. (2022) provides an in-depth review of coir fiber and coir fiber reinforced cementitious composites (CFRC) over the past two decades. It covers the extraction process, morphology, chemical composition, and tensile performance of coir fibers. The review also examines the physical and mechanical properties of CFRC, including density, thermal and acoustic insulation, compressive strength, and impact resistance. Additionally, it discusses various modification techniques, such as surface treatments and matrix adjustments, to enhance the bond strength and mechanical behavior of CFRC. Coir, as an agricultural by-product, offers environmental benefits due to its low embodied carbon footprint and high tensile toughness, making it a promising alternative to synthetic fibers like steel and polypropylene. The paper also highlights the need for further studies on the long-term performance, seismic and fire resistance of CFRC, as well as the potential use of coir fiber in geopolymer and coconut shell aggregate concrete. Despite the positive attributes of coir, the practical application in construction is still in its early stages, and more research is required to optimize its performance in cementitious materials.

Osama Zaid et al. (2023) investigates the impact of fly ash (FA) as a partial replacement for ordinary Portland cement (OPC) and waste glass (WG) as a partial replacement for sand in natural fiber-reinforced concrete. The findings reveal that the high surface area of fly ash and the angular texture of waste glass reduced the workability of the concrete. The M4 mixture (WG16-FA20-CFs2.5) achieved the highest compressive strength of 48.52 MPa after 90 days of curing, which was 15.8% higher than the control specimen. Flexural strength was also enhanced by 9.57% in the M4 mixture due to the improved hydration from fly ash and the crack-mitigating properties of coconut fibers (CFs). The addition of WG reduced the bulk density of the concrete due to its low specific gravity. However, WG increased the water absorption, sorptivity, and permeability of the concrete due to the fine particle size of the waste glass and the presence of CFs, which contributed to the formation of permeable pores. FTIR analysis showed no new chemical elements, with the creation of C-S-H gel remaining consistent across all mixtures. The crystallization of calcium hydroxide slightly increased, which may explain the enhanced performance. Overall, the study concludes that the M4 mixture (16% WG, 20% FA, and 2.5% CFs) is the optimal combination for producing concrete with improved engineering properties.

Togay Ozbakkaloglu et al. (2024) study explores the effects of incorporating natural (coconut) and synthetic (glass) fibers into polymer-cementitious composites, focusing on their physical-mechanical properties and microstructure. Fourteen different mix ratios using both fiber types with polymer resin and ordinary Portland cement were tested, with evaluations including flow diameters, unit weight, water absorption, compressive and flexural strengths, ultrasound transmission rates, and microstructural analysis through SEM and EDS. The results highlight that the surface texture of fibers significantly influences the engineering properties of the composite, with coconut fibers showing great potential for high-performance materials due to their bondability with cement. Polymer resins improve adhesion with smoother fibers like glass, enhancing the interfacial transition zone (ITZ), while coconut fibers, with their rougher surface, may require additional treatment for optimal bonding. Both fiber types, when used in the right proportions, improve the strength and durability of the composite, making them suitable for concrete repair applications where enhanced adhesion and prevention of delamination are critical. The study underscores the potential of combining natural and synthetic fibers in polymer-cement composites, particularly for repair purposes, and lays the groundwork for future research to optimize fiber content and treatment methods for better bonding and mechanical properties.

S. Prakash Chandar et al. (2022) discusses the use of various cementitious materials as partial substitutes for cement in concrete production to reduce costs and environmental impact. Cement is a key component in concrete but is also the second-largest industrial source of CO₂ emissions. The review examines materials like fly ash (FA), metakaolin (MK), silica fume (SF), rice husk ash (RHA), ground granulated blast-furnace slag (GGBS), and alccofine, which have shown positive results when used as partial replacements for cement. These materials, primarily due to their pozzolanic properties, enhance the strength of concrete, though typically to a lesser extent than conventional cement. However, they can achieve the required strength over different curing time intervals. Alccofine, in particular, has been highlighted for its fine pore structure, which enhances chloride diffusion resistance and chemical durability. Some materials like FA and RHA have been shown to improve concrete's resistance to corrosion, especially in coastal environments. The paper also notes that the amount of water needed to maintain workability can increase or decrease depending on the material used. In conclusion, cementitious materials can be a sustainable and cost-effective alternative to cement, contributing to both economic and environmental benefits in concrete production.

A. Bahurudeen et al. (2023) examines the potential of using waste glass as a sustainable alternative in concrete production, addressing the environmental concerns associated with river sand mining and raw material depletion in cement production. The review explores the synergistic use of waste glass combined with other industrial by-products such as slag, fly ash, and agricultural waste materials. It highlights the positive effects of incorporating waste glass as a partial replacement for fine aggregates, coarse aggregates, and even cement in concrete. The addition of waste glass improves the mechanical properties of concrete, including compressive and flexural strength, and enhances its workability, particularly in ternary blends, due to the smooth surface of glass particles. Waste glass also reduces the permeability of concrete, improving its durability and resistance to chloride ion penetration, while increasing its thermal insulation properties due to lower thermal conductivity. However, the review notes that research on the combined use of waste glass and other by-products is still limited, and more studies are needed to fully understand their combined effects on fresh, hardened, and long-term durability characteristics. The paper concludes that waste glass, when combined with other alternative materials, holds significant promise as an environmentally friendly and cost-effective solution for concrete production, though further research is necessary to optimize its use and industrial acceptance.

Yao Sun et al. (2023) evaluates the mechanical properties of concrete with 20% cement replacement using silica fume, metakaolin, and coconut fibers. The study was conducted in two phases: Phase 1 focused on optimizing the combination of silica fume and metakaolin for enhancing compressive strength in cement mortar, while Phase 2 examined the impact of varying coconut fiber contents on the properties of cement composites. The results revealed that the most effective mix for achieving high compressive strength (75.3 MPa) was a combination of 10% silica fume and 10% metakaolin. For fiber-reinforced composites, 6% coconut fiber content provided the best mechanical properties, with a compressive strength of 78.6 MPa and a modulus of rupture of 16.7 MPa. Increasing fiber content led to reduced density and increased moisture content, with higher water absorption observed at higher fiber contents. SEM analysis confirmed that the fibers were uniformly dispersed in the cement matrix, improving the material's toughness and integrity under load. X-Ray diffraction analysis revealed the presence of key compounds like SiO₂ and Fe₂O₃, which were primarily sourced from the silica fume and metakaolin. Overall, the study demonstrates the benefits of using silica fume, metakaolin, and coconut fibers for enhancing the mechanical and durability properties of concrete, offering insights for sustainable and high-performance construction materials. These findings are valuable for future research and practical applications in sustainable infrastructure development.

Kenneth Jae Elevado et al. (2024) investigates the use of agricultural waste materials—coconut shell ash (CSA), coconut shell granules (CSG), and coconut coir (CC)—as replacements for cement, sand, and fiber reinforcement in concrete production. Fifteen mix designs were tested with varying proportions of CSA (0%-20%), CSG (0%-20%), and CC (0%-2%), and the concrete's workability, unit weight, and mechanical properties were assessed after 28 days of curing. The results showed that higher concentrations of CSA, CSG, and CC reduced workability due to their higher absorption rates compared to conventional aggregates. Most modified mixes had lower unit weights than conventional concrete, with only Mix A10G0C1 exhibiting a slight increase of 1.62%. The highest compressive strength (26.11 MPa) was observed in the mix A0G0C2 (0% CSA, 0% CSG, 2% CC), while the lowest strength (7.60 MPa) was seen in mix A20G20C2. In terms of tensile strength, the highest value (3.24 MPa) was achieved in mix A0G20C2, while mixes with higher CSA, CSG, and CC concentrations showed reduced strength. The study's response surface methodology (RSM) model predicted that the optimal mix for maximum compressive strength was 0% CSA, 0% CSG, and 2% CC.

Overall, while incorporating all three agricultural wastes generally reduced the strength of concrete, the mixes with lower CSA and CSG, especially A0G0C2 and A0G20C2, showed promise for low-strength, non-structural applications such as patio slabs and pathways, suggesting their potential use in sustainable concrete production.

According to Naraindas Bheel et al. (2023) the use of Calcareous Fly Ash (CFA) as an additive to concrete, focusing on its effects on mechanical properties and sustainability. The study finds that incorporating up to 9% CFA improves concrete's compressive strength (35.89 MPa), flexural strength (5.71 MPa), and split tensile strength (3.52 MPa), with no additional benefit from higher CFA content. CFA-modified concrete also shows reduced embodied carbon due to lower cement usage, with CFA9C demonstrating the best eco-strength efficiency. Using Response Surface Methodology (RSM), the study developed a prediction model for CFA-modified concrete, achieving high R-Square values (0.94–0.95) for key mechanical properties, with experimental results deviating by less than 3.5% from predictions. The findings suggest that CFA can significantly reduce concrete costs by replacing cement while maintaining adequate strength and durability, offering a sustainable and cost-effective solution for concrete production. Daban A. Muhedin et al. (2023) evaluates the use of waste glass powder (WGP) as a cement replacement material in concrete, focusing on its impact on sustainability and mechanical properties. The findings show that replacing up to 15% of cement and sand with WGP significantly enhances concrete sustainability without negatively affecting compressive strength. The strength activity index suggests that WGP is an effective cement replacement up to 15%, supporting its role in producing sustainable concrete. The study also finds that the splitting tensile strength performance of concrete with WGP is comparable to its compressive strength. Microstructural analysis using SEM reveals improved concrete structure with more C-S-H formation and fewer cracks due to secondary hydration. Additionally, XRD analysis indicates a reduction in calcium hydroxide content as glass powder reacts with it in a pozzolanic process. Overall, WGP offers a promising alternative for sustainable concrete production without compromising strength or durability.

K.I.M. Ibrahim (2021) discusses the effects of substituting cement with Waste Glass Powder (WGP) in various concrete mixes, focusing on strength, durability, and workability. A 5% WGP substitution in ordinary concrete (Group 1) resulted in an approximate 8% increase in compressive strength and a 13% increase in tensile strength. However, at higher replacement levels (10-20%), both compressive and tensile strengths decreased, likely due to the smoothness of the recycled glass particles, which reduce adhesion with the cement paste and promote crack formation. In terms of durability, WGP replacement led to a significant reduction in water absorption across all concrete types. The reduction was most notable in Group 1 (ordinary concrete) at 27.78%, followed by Group 3 (fly ash concrete) and Group 2 (silica fume concrete) at 18.75% and 14.75%, respectively, which is attributed to the low water absorption of glass and the improved packing of fine WGP particles, enhancing the concrete's microstructure. Additionally, the density of all mixes decreased by around 3% with a 20% WGP substitution, due to the lower specific gravity of WGP compared to cement. The workability of all concrete types improved with higher WGP content, likely due to the smooth surface and low water absorption of the glass particles, which increased the fluidity of the mixes. The optimal dosage of WGP substitution for ordinary concrete was found to be 5%, which enhanced strength without compromising other properties. Furthermore, the color of the concrete remained unchanged with the addition of WGP. Overall, while lower levels of WGP substitution offer improvements in strength, durability, and workability, higher substitution rates lead to performance reductions, especially in terms of strength.

Akhil S. Raju et al. (2021) investigates the use of waste LCD glass powder, derived from discarded electronic devices, as a partial replacement for cement in concrete. The LCD glass powder was ground to a particle size of 45 μm or less and characterized using X-ray Fluorescence spectroscopy, which revealed SiO_2 , Al_2O_3 , CaO , and MgO as the major components. The study demonstrates that the incorporation of LCD glass powder significantly improves the strength and durability of concrete. Specifically, a 5% cement replacement with waste LCD glass powder achieved a 20%, 28%, and 36% increase in compressive strength after 7, 28, and 56 days, respectively, compared to the control mix. Additionally, it showed optimal results for chloride ion penetration and sorptivity. At 20% substitution, the concrete exhibited enhanced resistance to sulfate attack and acid exposure. The work also highlights the potential of using waste LCD glass powder as a pozzolanic material to mitigate environmental pollution by reducing cement consumption and recycling solid waste. The paper suggests that 5% replacement is the optimal level for achieving improved strength, while higher substitutions (up to 20%) benefit specific durability aspects. The study emphasizes the importance of using end-of-life LCD glass waste, particularly in countries like India, where its recycling rate is low, to contribute to sustainable construction practices.

Bassam A. Tayeh et al. (2022) explores the use of recycled Glass Powder (GP) as a cement replacement in eco-friendly mortar, specifically examining the effects of exposure to ammonium nitrate (NH_4NO_3) solutions on the mortar's physical and mechanical properties. A total of 60 cement mortar mixtures were prepared with GP passing through a 200 μm sieve, and the mortars were submerged in NH_4NO_3 solutions at concentrations of 5%, 10%, and 20% for exposure periods of 10, 30, and 60 days. The results showed that mortar containing GP was less affected by the NH_4NO_3 solution compared to conventional mortar, particularly in terms of density. After 60 days of immersion in a 20% NH_4NO_3 solution, the density reduction in glass mortar was less than that in ordinary mortar. Additionally, the compressive strength of mortars with 10% GP replacement reached approximately 60 MPa after 60 days, which was the highest strength observed in the study. This suggests that a 10% replacement level of GP is optimal for achieving both improved strength and resistance to chemical degradation caused by NH_4NO_3 exposure. The study also notes that increasing the GP content in mortar led to higher global density, but the unit weight of all mortar samples decreased with the increase in NH_4NO_3 concentration, attributed to the decomposition of certain mortar components. Overall, this research highlights the potential of using recycled glass powder in sustainable mortar formulations, offering improved durability against chemical attacks while reducing environmental impact through the reuse of waste materials.

According to R. Rajendran et al. (2021) the use of waste glass as a partial replacement for cement in concrete has gained attention as a sustainable solution to both reduce environmental pollution and mitigate the carbon footprint of cement production. In India, where around 21 million tons of glass waste are generated annually, this non-biodegradable material poses significant environmental challenges. Recent studies have explored incorporating finely ground glass powder (ranging from 600 μm to 75 μm) into concrete as a pozzolanic material to replace up to 25% of the cement content. The findings reveal that replacing up to 20% of cement with glass powder improves the compressive, tensile, and flexural strength of concrete, with the maximum compressive strength reaching 28.22 N/mm^2 after 28 days of curing. However, beyond the 20% replacement threshold, the strength and workability of the concrete decline, indicating that excessive glass content may negatively affect performance. This research highlights the potential of using waste glass as an alternative binder in concrete, offering an effective means of reducing waste and lowering cement's environmental impact, with the most favorable results observed at a 20% replacement level.

Babar Ali et al. (2022) study investigates the use of coconut fiber (CF) as a reinforcement in fiber-reinforced concrete (FRC) incorporating recycled aggregates (RA) to enhance its sustainability and mechanical properties. The research evaluates various concrete mixes with 50% and 100% RA replacing natural aggregates (NA), with and without CF, and the influence of superplasticizer (SP) on workability. Results showed that 2% CF (by weight of cement) improved the shear strength of plain concrete by up to 60%, with SP further enhancing the performance of recycled aggregate concrete (RAC). While CF increased water absorption and chloride permeability, SP addition effectively controlled these durability issues. Additionally, the study found that CF-reinforced concrete exhibited stable compressive strength when exposed to subtropical outdoor conditions for a year. Scanning electron microscopy (SEM) observations revealed minimal shrinkage of CF filaments in cement paste. This research highlights the potential of combining CF and SP with RA to produce eco-friendly, high-performance FRC, offering a viable solution to reduce the environmental impact of traditional concrete while maintaining or improving its mechanical properties.

Syed Omar et al (2023) replaced coarse aggregate with industrial slag and Malkapuram Devaiah et al studied the material and water absorption (2024).

III. SUMMARY OF REVIEW

From above studies on sustainable concrete production highlight the potential of using agricultural waste materials, such as coconut coir, coconut shell ash (CSA), and coconut shell granules (CSG), as alternatives for cement and sand replacements, as well as fiber reinforcement. These materials offer significant environmental benefits due to their low carbon footprint and abundant availability. Coir, in particular, has been recognized for its high tensile strength, toughness, and resistance to saltwater, making it an eco-friendly alternative to synthetic fibers like steel and polypropylene. It can enhance the mechanical properties of concrete, including tensile strength and toughness, while reducing brittleness. However, challenges related to the absorbent nature of coir, which can reduce workability, and issues with drying shrinkage and bonding behavior, still need further investigation. Incorporating coir into cementitious composites (CFRC) has shown positive results in terms of improving mechanical properties such as density, compressive strength, and impact resistance. However, surface treatments and adjustments to the matrix are often

necessary to improve the bond strength between the fibers and the cementitious matrix. Likewise, the addition of other agricultural by-products like rice husk ash (RHA) and fly ash (FA) has been shown to enhance the durability and strength of concrete, contributing to more sustainable construction practices. Furthermore, the potential of waste materials like fly ash, waste glass, and coconut fiber in combination with traditional materials has demonstrated improved hydration, crack-mitigating properties, and flexural strength. Despite the promising results, several studies point out that high concentrations of agricultural waste materials can adversely affect the workability and strength of concrete, especially when incorporated in large quantities. For instance, higher proportions of CSA, CSG, and CC tend to reduce workability due to their high absorption rates, while some mixes exhibit reduced tensile and compressive strengths. The optimal mix designs often involve lower proportions of these waste materials, such as 0% CSA and 2% CC, achieving improved compressive and split tensile strengths. Response surface methodology (RSM) models have been used to predict the optimal combinations of these materials, pointing toward their use in low-strength, non-structural applications like patio slabs and pathways.

Overall, while the integration of agricultural waste in concrete production is still in its early stages, it holds considerable promise for creating more sustainable, durable, and cost-effective building materials. The studies reviewed underscore the need for further research into optimizing these materials, particularly focusing on their long-term durability, bonding behavior, and suitability for different structural applications. These findings pave the way for a more sustainable approach to construction, leveraging natural resources while minimizing environmental impacts.

REFERENCES

1. Ali, B., Hawreen, A., Ben Kahla, N., Amir, M. T., Azab, M., & Raza, A. (2022). A critical review on the utilization of coir (coconut fiber) in cementitious materials. *Construction and Building Materials*, 351, 128957. <https://doi.org/10.1016/j.conbuildmat.2022.128957>
2. Wang, B., Yan, L., & Kasal, B. (2022). A review of coir fibre and coir fibre reinforced cement-based composite materials. *Journal of Cleaner Production*, 338, 130676. <https://doi.org/10.1016/j.jclepro.2022.130676>
3. Althoey, F., Zaid, O., Majdi, A., Alsharari, F., Alsulamy, S., & Arbili, M. M. (2023). Effect of fly ash and waste glass powder as a fractional substitute on the performance of natural fibers reinforced concrete. *Ain Shams Engineering Journal*, 14(12), 102247. <https://doi.org/10.1016/j.asej.2023.102247>
4. Demirdağ, C., Nodehi, M., Bideci, A., Bideci, Ö. S., Tuncer, M., Gencil, O., & Ozbakkaloglu, T. (2024). The use of natural (coconut) and artificial (glass) fibers in cement – polymer composites: An experimental study. *Construction and Building Materials*, 412, 134895. <https://doi.org/10.1016/j.conbuildmat.2024.134895>
5. Chandar, S. P., & Santhosh, R. (2022). Partial replacement of cement with alternative cementitious material in the production of concrete: A review. *Materials Today*, 68(6), 2421-2426. <https://doi.org/10.1016/j.matpr.2022.02.114>
6. Navaneetha, E., Rao, P. N., & Bahurudeen, A. (2023). Compatibility of waste glass with other by-products for the production of sustainable concrete. *Journal of Building Engineering*, 80, 107922. <https://doi.org/10.1016/j.jobe.2023.107922>
7. Nawab, M. S., Ali, T., Qureshi, M. Z., Zaid, O., Ben Kahla, N., Sun, Y., Anwar, N., & Ajwad, A. (2023). A study on improving the performance of cement-based mortar with silica fume, metakaolin, and coconut fibers. *Case Studies in Construction Materials*, 19, e02480. <https://doi.org/10.1016/j.cscm.2023.e02480>
8. Lejano, B., Elevado, K. J., Fandiño, M. A., Ng, E. A., Datinguinoo, Z. A. N., & Oliveros, S. B. (2024). Experimental investigation of utilizing coconut shell ash and coconut shell granules as aggregates in coconut coir reinforced concrete. *Cleaner Engineering and Technology*, 21, 100779. <https://doi.org/10.1016/j.clet.2024.100779>
9. Waqar, A., Bheel, N., Almujiabah, H. R., Benjeddou, O., Alwetaishi, M., Ahmad, M., & Sabri Sabri, M. M. (2023). Effect of Coir Fibre Ash (CFA) on the strengths, modulus of elasticity and embodied carbon of concrete using response surface methodology (RSM) and optimization. *Results in Engineering*, 17, 100883. <https://doi.org/10.1016/j.rineng.2023.100883>
10. Muhedin, D. A., & Ibrahim, R. K. (2023). Effect of waste glass powder as partial replacement of cement & sand in concrete. *Case Studies in Construction Materials*, 19, e02512. <https://doi.org/10.1016/j.cscm.2023.e02512>
11. Ibrahim, K. I. M. (2021). Recycled waste glass powder as a partial replacement of cement in concrete containing silica fume and fly ash. *Case Studies in Construction Materials*, 15, e00630. <https://doi.org/10.1016/j.cscm.2021.e00630>
12. Raju, A. S., Anand, K. B., & Rakesh, P. (2021). Partial replacement of Ordinary Portland cement by LCD glass powder in concrete. *Materials Today: Proceedings*, 46(10), 5131-5137. <https://doi.org/10.1016/j.matpr.2021.03.049>

13. Almeshal, I., Al-Tayeb, M. M., Qaidi, S. M. A., Abu Bakar, B. H., & Tayeh, B. A. (2022). Mechanical properties of eco-friendly cements-based glass powder in aggressive medium. *Materials Today: Proceedings*, 58(4), 1582-1587. <https://doi.org/10.1016/j.matpr.2022.07.129>
14. Rajendran, R., Sathishkumar, A., Perumal, K., Pannirselvam, N., Lingeshwaran, N., & Madavarapu, S. B. (2021). An experiment on concrete replacing binding material as waste glass powder. *Materials Today: Proceedings*, 47(15), 5447-5450. <https://doi.org/10.1016/j.matpr.2021.03.085>
15. Ali, B., Farooq, M. A., El Ouni, M. H., Azab, M., & Elhag, A. B. (2022). The combined effect of coir and superplasticizer on the fresh, mechanical, and long-term durability properties of recycled aggregate concrete. *Journal of Building Engineering*, 59, 105009. <https://doi.org/10.1016/j.job.2022.105009>
16. Dr. Syed Omar Ballari, (2024), "Mechanical, water absorption, Efflorescence, Theoretical, computational and experimental research in the area of material science soundness, and Morphological, analysis of the Hybrid brick composites". *Matéria (Rio de Janeiro)*
17. Seelam Srikanth, Syed Omar Ballari, and Sala Eswar (2022), "Framework for Freight Movement in Bangalore City, India", *IOP Conference Series: Earth and Environmental Science.*, IOP Conference Series: Earth and Environmental Science. (SCOPUS).
18. Syed Omar Ballari, M. Raffikbasha, Anil Shirgire, Lalit S. Thakur, S. Thenmozhi, B. Sarath Chandra Kumar (2023), "Replacement of coarse aggregates by industrial slag" *Materials today Proceedings*, Available online 6 April 2023. <https://doi.org/10.1016/j.matpr.2023.03.491>. (SCOPUS).
19. Syed Omar Ballari, Angalkuditi Srinivas, Manish Gupta; Kiran Dhobal; Pathan Shahnavajkhan Akabarkhan; Dasari Veera Reddy (2023), "A Critical Analysis of Applying Computer Vision In Building an Intelligent System" 3rd International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE), 12-13 May 2023, Greater Noida, India, **INSPEC Accession Number:** 23484788, IEEE Publication, DOI: 10.1109/ICACITE57410.2023.10182958. (SCOPUS) Page(s):562 - 566
20. Syed Omar Ballari (2023), "Modelling of heterogeneous traffic using image processing software" *Multimedia Tools and Applications*, <https://doi.org/10.1007/s11042-023-16363-0>, Springer Nature Switzerland. (SCOPUS).



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