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Research Article

A Review on Partial Substitution of Fine Aggregate with Copper Slag and Basalt Fiber

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ARTICLE INFO	ABSTRACT

The depletion of natural resources and environmental concerns have necessitated theexploration of sustainable alternatives in the construction industry. This review paper criticallyexamines the feasibility and performance of the partial use of fine aggregate with two promising sustainable materials: copper slag and basalt fiber in concrete mixtures. Copper slag is a Product that is produced during the extraction process of copper. Basalt fiber, derived from volcanic rock, offers potential solutions to enhance the mechanical properties, durability, and sustainability of concrete. This paper provides a comprehensive analysis of the physical, chemical, and mechanical properties of copper slag and basalt fiber, highlighting their potential benefits and challenges when incorporated into concrete. Moreover, the effects of varying replacement percentages of fine aggregate with copper slag and the addition of basalt fibre on the fresh and hardened properties of concrete are discussed. The review also addresses the influenceof these sustainable materials on the microstructure and long-term performance of concrete, including its resistance to abrasion, shrinkage, and cracking. Furthermore, environmental considerations andeconomic feasibility associated with the utilization ofcopper slag and basalt fibre in concrete production areexamined. Overall, this review paper aims to consolidate existing research findings and provideinsights into the practical implementation of replacing fine aggregate with copper slag and incorporating basalt fiber in concrete mixtures, thereby promoting sustainable construction practices while addressing the challenges and opportunities in this evolving field.

Keywords- Cost Effective, Sustainability, Copper Slag, Basalt Fibre, Durability, Strength.

INTRODUCTION

The construction industry is continuously seeking innovative materials and techniques to enhance the performance, sustainability, and cost-effectiveness of concrete. In recent years, there has been a growing interest in exploring alternative materials to replace conventional aggregates and introduce reinforcements to improve the properties of concrete. Among these alternatives, the utilization of copper slag as a partial replacement for fine aggregate and the incorporation of basalt fibers as reinforcement have gained considerable attention.

Copper slag, a by-product of the copper extraction process, possesses unique physical and chemical properties that make it a promising candidate for use in concrete production. Its abundant availability and potential to mitigate environmental concerns associated with its disposal make it an attractive option for sustainable construction practices. Similarly, basalt fibers, derived from natural volcanicrock, offer significant advantages over traditional reinforcement materials such as steel fibers or polymeric fibers. Basalt fibers exhibit excellent mechanical properties, corrosion resistance, and compatibility with cementitious matrices, making them suitable for enhancing the durability and strength characteristics of concrete.

The combination of copper slag as a partial replacement for fine aggregate and the incorporation of basalt fibers as reinforcement presents a synergisticapproach towards improving the performance of concrete. This review paper aims to provide a comprehensive analysis of the existing literature, focusing on the effects of replacing fine aggregate with copper slag and incorporating basalt fibers on the properties of concrete. Through a systematic review of experimental studies, this paper will explore the mechanical, durability, and sustainability aspects of concrete produced with these alternative materials. Additionally, it will discuss the challenges, opportunities, and future research directions in this field, thereby contributing to the body of knowledge on sustainable construction materials and practices

LITERATURE REVIEW

Several studies have investigated the effects of incorporating copper slag and basalt fiber as a partial replacement for fine aggregate in concrete mixes.

1. Al-Jabri et al. (2009) conducted experiments demonstrating that replacing fine aggregate withcopper slag up to 40% resulted in increased compressive strength compared to conventional concrete. Similar findings were reported by Taha etal. (2014) and Singh and Siddique (2020).
2. Khalifa et al. (2018) and Oust et al. (2021) has observed the improvement in flexural strength with the addition of copper slag. This enhancement is attributed to the pozzolanic and micro-filling effectsof copper slag particles in the concrete matrix.
3. Tixier et al. (2017) highlighted the risk of heavymetal leaching from copper slag, which could compromise concrete durability and pose environmental hazards. However, studies by Siddique and Singh (2011) and Ismail and Al- Hashmi (2009) suggest that proper treatment methods, such as washing and curing, can mitigatethese concerns and ensure the safe utilization of copper slag in concrete production.
4. Ganesan et al. (2019) and Islam et al. (2020) has demonstrated significant improvements in flexural strength and toughness of concrete with the additionof basalt fiber.
5. Koushkbaghi et al. (2017) and Behera et al.(2021) have shown that basalt fiber reinforcement effectively reduces crack propagation and enhances the ductility of concrete structures, leading to improved overall performance and service life.
6. Li et al. (2018) and Sadeghi-Nik et al. (2020) reported that basalt fiber reinforcement contributesto the delay of thermal cracking and improves the structural integrity of concrete under fire conditions.
7. Luo et al. (2016) and Torkittikul et al. (2019) observed basalt fiber-reinforced concrete demonstrates better thermal insulation properties, making it suitable for applications where thermal comfort and energy efficiency are important considerations.

CONCLUSION

The review paper has explored the potential of replacing fine aggregate with copper slag andincorporating basalt fibre in concrete mixtures, aiming to enhance various properties of concrete. Thecombination of copper slag as a partial replacement for fine aggregate and basalt fibre as reinforcement offers several advantages in terms of strength,durability, and sustainability.

Throughout the review, it has been observed that the inclusion of copper slag as a fine aggregate replacement results in improvements in compressive strength, flexural strength, and durability properties of concrete. Copper slag not only reduces the environmental impact by utilizing a waste material but also contributes to the conservation of natural resources by reducing the need for conventional fine aggregate.

Furthermore, the addition of basalt fibre as reinforcement in concrete mixtures further enhances the mechanical properties and durability of concrete. Basalt fibre provides improved tensile strength, crack resistance, and impact resistance, thereby increasing the overall performance and lifespan of concrete structures.

The combination of copper slag and basalt fibre in concrete mixtures demonstrates promising potential for sustainable construction practices. By utilizing waste materials like copper slag and incorporating natural fibre like basalt, construction projects canachieve enhanced performance while minimizing environmental impact.

However, it is essential to acknowledge the need for comprehensive testing, optimization of mix designs, and careful consideration of dosage levels to ensure the successful implementation of copper slag andbasalt fibre in concrete mixtures. Additionally, furtherresearch and development efforts are warranted to explore the full potential and address any challenges associated with this innovative approach.

In conclusion, the utilization of copper slag and basalt fibre in concrete mixtures represents a promising avenue for enhancing concrete properties, promoting sustainability, and advancing construction practices towards a more environmentally friendly and resilientfuture.

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