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Experimental Investigation of Bamboo Leaf Ash and Rice Husk Ash as Partial Replacement of Cement in Concrete

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ABSTRACT:

The study involves varying replacement levels to understand their impact on concrete properties. Through quantitative analysis, the research aims to determine the effects on compressive strength, flexural strength, and durability of concrete mixtures. Additionally, the project explores the economic feasibility of utilizing BLA and RHA by considering cost implications and availability. Environmental aspects are also evaluated to understand the sustainability benefits, including reduced carbon footprint and waste utilization. The outcomes of this investigation aim to provide insights into optimizing concrete mix designs, contributing to sustainable construction practices by harnessing the potential of agricultural waste materials in the construction industry.

Introduction

This study delves into the potential of Bamboo Leaf Ash and Rice Husk Ash as eco-friendly alternatives to traditional cement in concrete production growing environmental concerns and the need for resource conservation, exploring these agro-waste materials' effectiveness in enhancing concrete properties becomes imperative This research aims to assess the feasibility of utilizing these ashes, examining their impact on the structural and environmental performance of concrete mixes. By investigating their properties and suitability, this study contributes to a greener and more efficient construction industry.

Cement is a synthetic building material utilized in construction for binding. Its production demands significant energy and high temperatures, approximately 1500°C, leading to the emission of hazardous gases such as CO2, NO3, and CH4 into the atmosphere.

Concrete is a composite material comprising various components, including a binding base that encapsulates aggregates in the form of particles or fragments [1]. Concrete is composed of cement, aggregates, chemical and mineral admixtures, and water, making up a significant portion of artificial materials. The Earth sees the use of concrete in billions of tons, leading to the annual emission of one million metric tons of CO2 from cement consumption and production, which poses environmental risks. The manufacturing process of Portland cement is expensive, requiring high energy consumption at high temperatures.

Literature Review

1. **According to V.N. Pozzolanic, et. al. (2006),** the experimental findings indicate that bamboo leaf ash exhibits commendable pozzolanic properties by Reacting with calcium hydroxide to form calcium silicate hydrate, the pozzolanic activity of bamboo leaf ash demonstrates an increase with both time and temperature.
2. **Olofintuyi, I. O, Oluborode, K.D, Popoola, O. O. (2016)** BLA has been acknowledged as a valuable biomass resource by various researchers, underscoring its significance in various applications. The commitment to energy conservation and reducing CO2 emissions in cement manufacturing is underscored in this study. It demonstrates that integrating BLA into cement

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for lightweight and mass concrete construction could lead to significant energy savings when the findings of this research are applied on a larger scale.

3. **Olutoge F.A., et. al. (2017)** The investigation revealed that BLA encompasses key chemical constituents of cement, albeit in varying quantities compared to OPC. This characteristic renders BLA a viable substitute for OPC at a suitable percentage. The specific gravity of the obtained BLA was lower than that of the replaced OPC, indicating a greater volume of BLA for mass substitution. Furthermore, a 10 to 20% replacement of OPC with BLA was observed to enhance the workability of the concrete.
4. **Alake Olaniyi, Olubunmi, and Ata Olugbenga (2018)** The chemical and physical attributes of bamboo leaf ash exhibit variations based on calcination temperatures, with those at 500°C, 600°C and 700°C showing silica content surpassing 25.00% (BS EN 197-1-2009). Notably, the ash calcined at 600°C demonstrated the highest combined content of 86.31%, meeting the specifications for classifying as acidic C pozzolans according to (ASTMC618:2008). Consequently, it is considered the most suitable ash for the intended purpose.
5. **S. Divya, P. Atchaya, G. Gayathri V. Lakshmi (2021)** Substituting rice husk ash in concrete can notably decrease greenhouse gas emissions. This approach holds the potential to acquire additional carbon credits, offering an avenue for environmental benefits.
6. **AsperGashawAbebaw, BahiruBewket, andShumetGetahun (2021),** In the experimental investigation, Bagasse Ash (BLA) was used as a cement substitute in concrete production. It was concluded that the workability of concrete decreases with a higher BLA replacement. Meanwhile, the setting time, water percentage for consistency, and soundness of the cement paste all showed an increasing trend.
7. **Bassirou Kone, et. al. (2022)** Concrete workablity The reduction occurs with an elevation in RHA and CS content. Additionally, as the substitution of RHA and CS increases, the setting time is extended. Concrete incorporating RHA and CS exhibits enhanced compressive and splitting tensile strength in both short and long durations compared to RHA and control concrete, with an optimal mix of ICSTORHA.
8. **Prem kumar V., Vasugi V. (2022)** Bamboo stem ash (BSA) has the potential to decrease the density of mortar due to its lower density compared to cement [11]. With the addition of bamboo fiber (BF) from 3% to 4%, there was a slight increase in the dry density of mortars when replacing 7.5% to 10% of cement with BSA. The optimum dosage can be BSA at 5% and BF at 1.5% as it reduces the dry density by 22.8% compared to the control mortar.
9. **Rajiv Sharma Leihaothabam, Khwairakpam Sachidananda (2023)** The proportion of silicon dioxide in BLA exceeds that in OPC by more than three times, leading to the formation of calcium silicate hydrate (C-S-H) during secondary hydration at later stages of strength development. With an increased amount of BLA added, more water is required in the standard consistency test. As the percentage of BLA increases, the setting time of concrete also increases. Workability decreases in proportion to the percentage of BLA. The density of OPC mixed with BLA is lighter, as the specific gravity of BLA is lower than that of OPC, making it a preferred choice in certain applications.
10. **Catherine Mayowa IKUMAPAYI, Oluwaseun Ayooluwa JEGEDE (2023)** Bamboo leaf ash can be employed in construction, particularly in non-critical concrete areas such as German floors or blinding, where attaining high concrete strength is not a primary concern. Utilizing bamboo leaves in the production of bamboo leaf ash serves as a method to decrease environmental waste. Studies have shown that bamboo leaf ash does not adversely affect the linear expansion of concrete. Concretes incorporating bamboo leaf ash are less likely to experience expansion due to ASR when used in actual construction.

Conclusion

The Incorporation of rice husk ash into concrete as a replacement material holds significant potential material has potential to significantly decrease greenhouse gas emissions. This suggests a positive impact on environmental sustainability, offering the opportunity to

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earn carbon credits. The experimental investigation into the utilization of Bagasse Ash (BLA) as a cement alternative substituting material indicates a decrease in workability with an increase in the replacement amount of BLA. However, it is associated with increased setting time, consistency of cement, and soundness of cement paste are influenced by the amount of BLA used. The physical and chemical properties of bamboo leaf ash exhibit variations based on calcination temperatures, with specific temperatures impacting these properties. with certain temperatures meeting the requirements for class acidic C pozzolans. Ash calcined at 600°C is identified as the most suitable for use. In summary, the studies collectively highlight the potential of alternative materials such as rice husk ash and various forms of bamboo ash as sustainable substitutes in concrete production. While these materials offer environmental benefits, their impact on concrete properties, workability, and strength should be carefully considered in practical applications. Further research and experimentation are crucial for optimizing their use and ensuring the development of environmentally friendly and structurally sound construction materials.

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