The Experimental Study on M25 Grade of Concrete with Partial Replacement of Cement by Rice Husk Ash &Sugarcane Ash

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***Abstract*—This thesis explores the enhancement of concrete's compressive strength through the partial replacement of Ordinary Portland Cement (43 grade) with eco-friendly alternatives—Sugarcane Bagasse Ash (SBA) and Rice Husk Ash (RHA). By incorporating varying proportions of SBA and RHA (0%, 10%, 20%, and 30%), a comprehensive study was conducted to evaluate their impact on M30 grade concrete. A total of 90 concrete cubes (150 mm × 150 mm × 150 mm) were cast and tested at intervals of 7, 14, and 28 days, with three samples evaluated for each duration across all mix variations.**

The concrete mix designs were tailored to achieve the target strength, and the results demonstrated a notable improvement in compressive strength with certain combinations of SBA and RHA. The performance trends were graphically represented to highlight the relationship between ash content and compressive strength. The findings confirm that both SBA and RHA are promising supplementary materials that not only enhance strength but also improve the fresh and hardened properties of concrete, paving the way for more sustainable construction practices.

***Keywords*—Rice Husk Ash (RHA), Sugarcane Bagasse Ash (SBA), Cement Replacement, Concrete, Compressive Strength, Workability.**

I. INTRODUCTION

The construction industry has been grappling with a sharp and continuous rise in the cost of building materials. This upward trend has pushed governments, private sectors, and individuals to actively seek locally available alternatives that can either partially or conventional materials in construction. One of the most affected materials is cement, which plays a crucial role in concrete production. To meet the soaring demand while managing costs, researchers turned to partial cement replacement When reinforced with steel, concrete exhibits even greater strength and load-bearing capacity, making it suitable for everything from residential homes to large-scale infrastructure.

Being a heterogeneous material, the quality of concrete heavily depends on the nature of its components and the proportions in which they are combined. Thus, thoughtful material selection and precise mix design are key to producing high-performance, cost-effective, and sustainable concrete.

II. LITERATURE REVIEW

2.1 Research Background

The following details of all the research work done on paper waste used in concrete mix all around the world, with thorough study of these research papers I was able to carry on my research work more conveniently and effortlessly.

1. Das K. C. and Tollner E.W.,(1998):
"Composition Pulp and paper Industry Solid Waste: Process Design and Product Evaluation", Pulp and paper Industry Solid Wastes, Improving handling characteristics of sludges and ash. Reducing weight, moisture content and volume, and removing nuisance due to odors. The best mix from a Degradation stand point was 57% (dry weight basis) sludge, 25% grit, 6% bark and 12% ash. The mix (-) had an initial moisture content of 54% and a UN ratio of 412.7. From a degradation standpoint the ammonium nitrate amended mixes result in greater amount of pulp mill solids being processed within a given time period. From a product quality standpoint, chicken litter amended compost was superior. It provided higher and a wider Variety of nutrients.

1. Monte M.C., Fuente E., Blanco A. and Negro C., (2009): "Waste management from Pulp and Paper Production in the European Union", Paper industry wastes, pulp and paper sludge, solid waste generation, waste recovery, waste minimization. The European paper industry generates about 11 million tonnes of waste, 70% of which originates from recycled paper production. The waste is very diverse in composition and consists of rejects, different types of sludges and, in case of on-site incineration, ashes.

The production of pulp and paper from virgin pulp generates less waste and the waste has the same properties as deinking waste, although with less inorganic content. Within the European Union several already issued and other, foreseen directives have great influence on the waste management strategy of paper producing companies. Through legislation, the landfill option is restricted, although it has not phased out on-site landfills.

2. Likon Marko and Trebše Polonca, (2012): "Recent Advances in Paper Mill Sludge Management", Paper Mill Plant, this paper examined the geotechnical properties of lateritic soils modified with coconut shell and husk ash with a view to obtaining a cheaper and effective road stabilizer. The modern sustainable management of production processes should be based on the industrial ecology approach, of which an essential element is the eco-symbiosis theory. Pulp and paper industry producing enormous quantities of solid waste what presents huge environmental burden. Appropriate managing with such a waste is most crucial task for modern pulp and paper industry. Many innovative approaches for conversion of the PMS into useful materials have been done in past two decades, but for many of them the markets demands have been too small for successful diverting of PMS from the landfill disposal.

III. PROPOSED WORK

The proposed research aims to evaluate the potential of Rice Husk Ash (RHA) and Sugarcane Bagasse Ash (SCBA) as partial replacements for cement in concrete production. Cement is a major contributor to carbon emissions, and identifying sustainable alternatives is crucial for reducing the environmental impact of the construction industry. Both RHA and SCBA are agricultural by-products rich in silica, and when properly processed, they exhibit pozzolanic properties that can enhance the performance of concrete.

The experimental work will involve replacing cement with RHA and SCBA at varying percentages—typically 5%, 10%, 15%, and 20%—by weight of cement. These materials will be collected, dried, sieved, and subjected to chemical analysis to confirm their composition. Standard mix designs for M20 or M25 grade concrete will be prepared with different proportions of RHA and SCBA, both individually and in combination.

Concrete specimens such as cubes, cylinders, and beams will be cast and cured for standard periods (7, 14, and 28 days). A series of tests will be conducted to evaluate the mechanical properties, including compressive strength, split tensile strength, and flexural strength. Additionally, workability tests such as slump tests will be carried out to assess the effect of ash replacement on the fresh concrete mix.

IV. RESULTS

The experimental investigation revealed that partial replacement of cement with Rice Husk Ash (RHA) and

Sugarcane Bagasse Ash (SCBA) significantly affects the mechanical properties of concrete. The key findings are

as follow.

1. Compressive Strength: Concrete mixes with 10% to 15% combined replacement of cement with RHA and SCBA showed comparable or slightly improved compressive strength compared to conventional concrete after 28 days of curing.
2. Workability: The addition of RHA and SCBA slightly reduced the workability of concrete mixes, as observed in slump test results. However, the reduction was within acceptable limits and could be managed by using plasticizers.
3. Split Tensile Strength: Moderate replacement levels (up to 15%) exhibited satisfactory tensile strength, confirming the structural adequacy of the mix for general applications.
4. Flexural Strength: Similar trends were observed in flexural strength tests, with mixes containing 10% RHA and SCBA achieving strength values close to that of the control mix.
5. Durability Indicators: Preliminary observations indicated improved resistance to surface cracking and potential enhancement in durability

due to the finer particles and pozzolanic nature of the ashes.

The results obtained will be compared to those of conventional concrete to determine the impact of RHA and SCBA on strength and performance. The research will also explore the potential benefits in terms of cost reduction and sustainability. Through this work, the study aims to contribute to the development of eco-friendly and durable concrete that supports waste material utilization and reduces dependence on conventional cement.

Overall, the results support the partial substitution of cement with RHA and SCBA in concrete without significant loss of performance, particularly at 10%–15% replacement levels.

V. CONCLUSION

The study demonstrates that Rice Husk Ash (RHA) and Sugarcane Bagasse Ash (SCBA) have the potential to be used as partial replacements for cement in concrete. The inclusion of these agricultural by-products not only improves the sustainability of concrete but also contributes to waste management and environmental conservation. The experimental results suggest that up to a certain percentage (typically between 10–15%) of RHA and SCBA replacement can yield satisfactory mechanical properties without significantly compromising the strength and durability of concrete. The findings support the feasibility of using RHA and SCBA in real-world construction applications, especially in low to moderate strength concrete works.

VI. FUTURE SCOPE

This study opens up several avenues for further research and practical application. Future work can focus on enhancing the performance of RHA and SCBA concrete by optimizing their fineness and mix proportions.

Detailed durability studies under aggressive environmental conditions can help determine long-term performance. The potential use of these ashes in high-performance and precast concrete applications can also be explored. Additionally, a life cycle assessment and economic analysis can highlight the environmental and cost benefits, especially in large-scale and rural construction projects.

a. Further research can be conducted to optimize the particle size and processing techniques of RHA and SCBA to enhance their pozzolanic activity.
b. Long-term durability studies, including resistance to acid attack, chloride penetration, and carbonation, should be carried out.
c. Field trials can be conducted to assess the real-time performance of these alternative concrete mixes in various environmental conditions.
d. Life cycle assessment (LCA) and costbenefit analysis can be performed to evaluate economic and environmental gains on a larger scale

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