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REVIEW ON REPLACEMENT OF CEMENT WITH SUGARCANE BAGASSE ASH IN CONCRETE

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ABSTRACT

Cement usage within the construction industry is one of the top sources of global CO_2 emissions and alternative solutions are needed. Sugarcane bagasse ash (SCBA), a by-product from sugar industries, has shown potential as partial cement replacement material based on its pozzolanic behaviour. This review assesses the potential of SCBA as a cement replacement material in terms of its chemical composition, effect on concrete properties and environmental benefits.

Keywords – Sugarcane bagasse ash, Cement replacement, Waste utilisation

1. INTRODUCTION

Based on studies conducted until now, the recent advancements suggest that SCBA can enhance the compressive strength of concrete, increase durability and resistance to chemical attack when processed and incorporated at appropriate percentages and thus contribute in reducing the environmental footprint of cement production. The challenges facing SCBA in include variations in ash and processing, and suggests directions for future where research is needed to enable more consistent aspects of SCBA.

2. LITRATURE REVIEW

Cement industry in today's time is becoming one of the most contaminating industries and because of this need arose to seek for Agricultural residues to be used as supplementary cementitious materials purchase due to its cheaper cost. In the quest for Portland cement alternatives for cement, SCBA is actually considered a viable substitute since it is produced from the sugar-cane industry and possesses pozzolanic properties that aid in the performance of concrete. The goal of this literature review is centered around the synthesization of various studies in order to formulate and analyze the possibility of substitution of SCBA for a part of cement used for concrete production.

1.Srinivasan, R., & Sathiya, K. (2010).- The concluded that Sugar-cane Bagasse ash is already causing serious environmental pollution, which calls for urgent ways of handling the waste. Bagasse ash mainly contains aluminium ion and silica. In this paper, Bagasse ash has been chemically and physically characterized, and partially replaced in the ratio of 0%, 5%,15% and 25% by weight of cement in concrete. Fresh concrete tests like compaction factor test and slump cone test were undertaken was well as hardened concrete tests like compressive strength, split tensile strength, flexural strength and modulus of elasticity at the age of seven and 28 days was obtained. The result shows that the strength of concrete increased as percentage of bagasse ash replacement increased.

2. Mangi, S. A., Jamaluddin, N., Ibrahim, M. W., Awal, A. A., Sohu, S., & Ali, N. (2017, November). - This research addresses the suitability of sugarcane bagasse ash (SCBA) in concrete used as partial cement replacement. Two grades of concrete M15 and M20 were used for the experimental analysis. The cement was partially replaced by SCBA at 0%, 5%, and 10%, by weight in normal strength concrete (NSC). The innovative part of this study is to consider two grades of concrete mixes to evaluate the performance of concrete while cement is replaced by sugarcane bagasse ash. The cylindrical specimens having size 150 mm x 300 mm were use and tested after curing period of 7, 14 and 28 days. It was observed through the experimental work that the compressive strength increases with incorporating SCBA in concrete. Results indicated that the use of SCBA in concrete (M20) at 5% increased the average amount of compressive strength by 12% as compared to the normal strength concrete. The outcome of this work indicates that maximum strength of concrete could be attained at 5% replacement of cement with SCBA. Furthermore, the SCBA also gives compatible slump values which increase the workability of concrete.

3. Abdulkadir, T. S., Oyejobi, D. O., & Lawal, A. A. (2014) -. The results of chemical test showed that SCBA has pozzolanic properties having met ASTM-595 (1985) with total sum of silica, alumina and ferric composition of 80.55%. The results showed a decrease in concrete density with increase in % replacement of SCBA. Average compressive strength of 26.8N/mm2 was obtained for control specimens at 28days (i.e. 0% SCBA) while 22.3, 20.1 and 17.3N/mm2 compressive strength at 28days were obtained for 10%, 20% and 30% replacement respectively. Pozzolanic activity index (PAI) of 83.2%,75% and 64.5% were obtained. This showed that only 10% and 20% replacement of cement by weight of SCBA satisfied ASTM-595(1985) specification for PAI. It was concluded that SCBA is a low weight material and 10% replacement of SCBA has the highest PAI. Also, 10% and 20% replacement of SCBA with compressive strengths of 22.3N/mm2 and 20.1N/mm2 are recommended for reinforced concrete.

4. Jagadesh, P., Ramachandramurthy, A., & Murugesan, R. (2018). - The mechanical properties of O-SCBA and P-SCBA blended concrete were studied. SCBA was added in different proportions (5%, 10%, ... 30%) by replacing cement. The mean of theoretical O-SCBA blended concrete density is 2409 kg/m3 and that of P-SCBA blended concrete density is 2422 kg/m3, indicates that the pore volume of P-SCBA blended concrete is filled by finer processed SCBA. The density of P-SCBA blended concrete increased to 0.78%, 1.04% and 1.21% at fresh state, 7th and 28th days compared to O-SCBA blended concrete.

5.Quedou, P. G., Wirquin, E., & Bokhoree, C. (2021) - The outcome of this experiment showed that SCBA could be used as a surrogate material for cement in the production of concrete. In view of the above discussion and considering strength and durability properties as viewpoints, the best combination would be to use 10 % of SCBA for non-structural elements purposes. This optimum level will not only enhance the performance of the cement blending but also contribute to preserving the environment.

6. Priya, K. L., & Ragupathy, R. (2016). - The present study focuses on the utilization of Sugarcane Bagasse Ash as replacement material for cement in concrete production. Sugarcane Bagasse ash contains high amorphous silica content and aluminium ion. For experimental investigations, Sugarcane bagasse ash and its chemical properties are obtained from KCP sugar factory, Andhra Pradesh. Ordinary Portland cement was partly replaced by sugarcane bagasse ash in the ratio of 0%, 5%, 10%, 15%, 20% and 25% by weight and the influence of Sugarcane bagasse ash as a partial replacement material has been examined on fresh concrete tests by Compaction factor test and Slump cone test as well as on hardened concrete with tests for Compressive strength, Split tensile strength, Flexural strength and Modulus of Elasticity. The results indicate that inclusion of Sugarcane Bagasse Ash in concrete up to 20% level significantly enhanced the strength of concrete. The highest strength was obtained at 10% Sugarcane bagasse ash replacement level.

7. Berenguer, R., Lima, N., Valdés, A. C., Medeiros, M. H. F., Lima, N. B. D., Delgado, J. M. P. Q., ... & Rangel, B. (2020) - With the analyses and results obtained, it is possible toconclude the following:

(i) Mineral addition improved concrete's properties, improving mechanical properties, refining capillary pores, and so forth. In view of pozzolanic determination Analyses results, in sugarcane bagasse samples, SCBA-A and SCBA-B, it was observed that, in some trials, SCBA-A was considered as a pozzolanic material, but in other analyses it was considered to have low reactivity, not reaching the minimum expected.

(ii) SCBA-A and SCBA-B samples did not have any type of processing (besides being dried and sifted in the0.075mm opening sieve), although results revealed that sugarcane bagasse ash SCBA-A can be considered as a low-pozzolanicity material. It is possible to be used as a pozzolanic material with some improvements, such as calcination and grinding, increasing its speci1c surface area and reactivity. Sugarcane bagasse ash SCBA-B samples were considered as medium reactivity pozzolanic material, because in analyses and assays performed the obtained results were higher than or close to the minimum of expected performance, becoming susceptible to be used as mineral addition.

8. Abdalla, T. A., Koteng, D. O., Shitote, S. M., & Matallah, M. (2022).- In this study, researchers have investigated the possibility of using SCBA up to 40% and its blend with SF as a partial replacement of cement to produce sustainable and high-strength concrete. The influence of cement replacement with SCBA and silica fume on the fresh properties of concrete (slump), the hardened mechanical properties of concrete (compressive strength, splitting tensile strengths, and flexural strength) and water absorption was assessed and compared to that of the control mix. The results demonstrated that slump content decreases with an increase in SCBA content. On the other hand, a high early strength of 25 MPa and above is obtained at 3-days with SCBA addition of up to 30%, with potential for the early striking of formwork and fast construction. In addition, concrete of a high 28-day strength in excess of 60 MPa can be produced by replacing cement with 10% SCBA, and concrete of a normal 28-day strength above 25 MPa can be obtained by substituting cement with SCBA up to 40%. At 28 days of age, the compressive strength, split tensile strength, and flexural strength followed the same trend.

3. CONCLUSION

To summarize, the utilization of sugarcane bagasse ash (SCBA) as a partial replacement of cement in concrete appears to be a viable and relieving option for green building practices. Many researches have shown that SCBA can enhance the performance of concrete material. In particular, these include improvements in compressive strength, reduction in porosity with improvement in conditions of durability. These enhancements are mostly due to the high silica content of the SCBA which combines with free calcium hydroxide to form more calcium silicate hydrate (C-S-H) and fill the voids in the concrete matrix.

Control variability during the application of SCBA in concrete castings is necessary to exploit its benefits, specific replacement levels must be ascertained because of the glass's composition, ash fineness and processing conditions relative to cement type, as high dosages may lead to poor workability and inadequate early age strength development of

the concrete. Furthermore, inducing effective SCBA use in concrete mix design helps in the environment by lessening cement utilzation and thus lowering CO2 emissions and also assists in management of agricultural wastes.

In the near term, future research is necessary in the direction of developing standardized processing of SCBA and performance over time duration so that its use becomes common. Finally, if all goes well in its enhancement use, SCBA would be majorly beneficial in construction as it would help with clean construction which cuts down on the use of harmful materials in line with the world's objectives in regard to sustainability while possibly saving money and resources.

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