International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

http://ijpsat.ijsht-journals.org
Vol. 23 No. 1 October 2020, pp. 49-52

A Review on the Sustainability of Sugarcane Bagasse Ash as a Supplementary Cementitious Material

Pritish Gupta Quedou

PhD Student, Institut pour la Recherche et l'Innovation Interdisciplinaire,
Université des Mascareignes, Mauritius

Abstract – The manufacturing process of cement results in the depletion of limited natural resources, consumption of excess energy and also leads to significant levels of carbon dioxide emission in the atmosphere. Consequently, researchers all over the World are concentrating their efforts in finding alternative materials that can replace cement on the long run. In this view, the focus has been turned onto utilising sugarcane bagasse ash as a source of raw and eco-friendly substitute material. Moreover, the possibility of using sugarcane bagasse ash in concrete have long been debated. The outcome of the experiments have showed positive and encouraging results especially for the mechanical and durability properties of concrete samples. The substitution of sugarcane bagasse ash in concrete would not only provide an economic relief, but also help to create a sustainable and pollution-free environment as the disposing of this waste creates many inconveniences to living organism.

Keywords – Sugarcane Bagasse Ash (SCBA), Cement, Concrete, Mechanical Properties, Durability Properties.

I. INTRODUCTION

The construction sector is considered as one of the most booming industries in the whole World and over the next decade the global construction industry is expected to grow rapidly. With the increasing expansion of urbanization, infrastructure renewal and the burgeoning needs of developing "megacities," the construction industry is expected to double within a decade and become a $6.7 trillion business by 2025, accounting for some 55 percent of global construction output [1].

The innovative use of building materials and sustainable construction can make a big difference to global environmental sustainability, mainly through the reduction in the use of natural resource consumption and energy-consuming materials like cement, steel, aggregates and aluminium. Conventional construction materials will fall short of their demand despite improved productivity and it is necessary to develop alternatives materials. Sustainable construction will not only enhance the resilience of our building and construction industry by using materials and but also will adopt construction methods that are environmentally friendly, faster, quieter and less labour-intensive [2].

In the recent years, the research related to agricultural wastes has intensified immensely in view to evaluate the potential for recycling as well as the prospect of eliminating the landfills. The availability of huge quantities of agricultural waste by-products in the form of ashes has attracted much consideration to concrete researchers to investigate their prospective use as a cement replacement material or admixtures. Various studies have demonstrated that these wastes can be used as a pozzolan in concrete and can improve both the strength and the durability properties of concrete when used as mineral admixtures. One of the wastes which has attracted much attention, particularly in tropical countries is the sugarcane bagasse ash (SCBA), which is

Corresponding Author: Pritish Gupta Quedou

obtained from cogeneration combustion boilers in sugar industries.

The process consists of extracting the cane juice from the sugarcane stem and leaving the fibrous matter as bagasse which represents 40-45% [3]. When this bagasse is burnt under controlled temperature, it results into ash. The burnt bagasse consists of approximately 50% of cellulose, 25% of hemi-celluloses and 25% of lignin. The bagasse ash is about 8-10% of the bagasse and contains unburned matter, silica and alumina [4]. Thus, enabling its use as a supplementary cementitious material (SCM). The use of sugarcane bagasse ash (SCBA) as SCM not only reduce the production of cement which is responsible for high energy consumption and carbon emission, but also can improve the compressive strength of cement-based materials like concrete and mortar [5]. Reference [6], stated that SCBA could be an essential raw material for the pozzolan production, mainly in tropical countries and also established that the pozzolanic activity of the bagasse can be attributed to the presence of amorphous silica (SiO_2).

Presently, 245 countries of the World cultivate sugarcane mainly for sugar and ethanol, and as per FAOSTAT 2018 about 1596 million tons of sugarcane is grown all over the World [7]. The three leading sugarcane producers are Brazil, India and China, which themselves represent more than 70% of the World total sugarcane producers. This directly indicates that a considerable amount of waste materials will be produced during the sugar or ethanol making process.

The SCBA is frequently disposed as landfills, spread over farms or dumped in ash ponds. Reference [8] pointed out that loading of ash to soils increases the salt content whose solubility may cause salinity problems in soils, resulting in an increase of electrical conductivity which may retard plant establishment and growth but also affect the soil and groundwater quality. Reference [9] observed that people exposed to these dust particles are prone to serious lung illness known as bagassosis. To reduce the negative effect of SCBA in our environment, various investigations have been carried out and the results showed that an optimum amount of SCBA could be used to replace cement in concrete, but depending on the quality of bagasse ash being used.

II. Literature Review

Many researches have been conducted on a potential use of SCBA as a replacement to cement in the production of concrete. The SCBA which is a by-product from the co-generation of electricity in sugar mills, has long been regarded as a waste material with no market value. Many scholars have put forward experiments involving SCBA as a partial replacement to cement, as a way to reduce cement production and as well as reducing the deposit of SCBA on land. Various researchers have carried out experiments and many positive conclusions have been obtained, which demonstrated the effectiveness of such materials.

Reference [10] experimented the use of 5%, 10%, 15%, 20%, 25% and 30% of SCBA as partial replacement to cement in the production of cement mortar. The latter concluded that 20% of BA could be used in the production of mortar. He further added that with the incorporation of SCBA, high strength concrete was developed at an early age, water permeability was reduced and was resistant to chloride permeation and diffusion. Reference [11] investigated the use of 10%, 20% and 30% of SCBA as partial replacement to cement. He concluded that 30% of SCBA had a higher compressive strength and a lower permeability than control concrete at ages of 28 and 90 days. According to [12] incorporation of SCBA up to 30% of cement replacement increased the resistance to chloride penetration. He further added that using 10% of SCBA produced concrete with good strength and low porosity. He concluded that replacement of 30% of SCBA was acceptable for the production of high strength concrete. Reference [13] studied the effect of replacing bagasse ash at 5%, 10%, 15% and 20% in concrete. The result showed that the addition of treated bagasse ash improved the workability, compressive strength, resistance to chloride ion penetration and decreased the rate of water absorption. Reference [14] analysed the use of SCBA at 5%, 10%, 15%, 20% and 25% as a replacement to cement in concrete production. The authors concluded that 5% of SCBA content improved the compressive strength and tensile strength of ordinary and lightweight concrete. They further added that at 5 % incorporation of SCBA improved the performance of concrete in terms of durability and impact resistance. Reference [15] investigated the use of sugarcane bagasse ash (SCBA) in mortar after controlled recalcination and grinding. The SCBA was processed in a muffle kiln at 600ºC for 1 hour and the 50% of the residual product passing 10µm was collected (SCBA600). He noted that SCBA600 improved the mortar paste with significant evidence of pozzolanic effect and pore improvement. A substantial decline in compressive strength at one day of curing as observed due to the retarding effect of the ash. After three days, there was a significant rise in the compressive strength. The latter concluded that at 28 days of curing period, the mortar exhibited the optimum mechanical performance, thus demonstrating the pozzolanic nature of SCBA600. Reference [16] investigated the use of bagasse ash (BA) in the production of high-performance concrete. The latter replaced

cement by BA up to 20% replacement level, and concluded that the increase in compressive strength at an early age was due to the reaction of bagasse ash with CaO which improved the hardening process. He further observed that the splitting tensile strength and flexural strength increased at 5-10% BA replacement. The water absorption values, sorptivity and porosity of the HPC decreased with increasing curing period. Reference [17] studied the use of processed bagasse ash (BA) as a cement replacing material. He observed that at higher replacement proportion of cement with BA resulted in higher normal consistency and longer setting time. He further noted that the workability of mortar and concrete containing BA decreased as the BA content was increased. The experiment also showed that replacement of BA from 5% to 10% resulted in better compressive strength. Reference [18] investigated the use of SCBA as partial replacement to cement at the percentage of 5%, 10%, and 15% by weight of cement. The latter concluded that for a constant water/cement ratio, the workabilityof the concrete decreased. However, it was noted that with the addition of 5% and 10% of SCBA, the compressive strength increased at 28 and 56 days. Reference [19] studied the use of sugarcane bagasse ash (SCBA) in concrete. SCBA was replaced by weight in the percentage of 5%, 10% and 15%, and tested for the mechanical properties. The water/cement ratio was maintained at 0.57 throughout the experiment. The authors concluded that the compressive strength, tensile strength and the flexural strength of concrete samples decreased with increasing SCBA values.

III. Objectives and Scope of Study

To optimize further on the SCBA, the following consideration should be given on this material, before it is used in concrete.

1) Additional investigation on the chemical composition and pozzolanic behaviour of SCBA should be carried out.
2) To re-view the concrete mix design and consider the most economical options.
3) To study the workability of fresh concrete.
4) To analyse the mechanical and durability properties of hardened concrete samples.
5) To compare the various properties exhibited by the SCBA-Cement blended concrete with standard concrete.

IV. Conclusion

After reviewing the various studies carried out on sugarcane bagasse ash as a cement replacing material, it can be opined that SCBA is indeed a material which can be used in the production of sustainable concrete. The results demonstrated that making use of SCBA in concrete increased the mechanical properties of the concrete samples. Some of the studies also showed that with increasing age period, the durability properties of the concrete understudy also increased. The replacement level of cement by SCBA could eventually decrease the carbon footprint by providing an alternative material, which is readily available and less expensive in terms of processing and manufacturing stages. SCBA could also save landfill deposit and contribute to a much greener environment.

REFERENCES

[1] Oxford Economics.: *Global Construction Perspectives.* (2013).

[2] Available at: http://www.globalconstruction2025.com/. [Accessed 25 February 2020]

[3] Building and Construction Authority.: *Sustainable Construction, Materials for Building* [Online] (2007).

[4] Available at: http://www.bca.gov.sg/sustainableconstruction/others/sc_materials_book.pdf.

[5] [Accessed 25 February 2020]

[6] Shafiq, N., Hussein, A. A. E., Nuruddin, M. F., Al Mattarneh, H.: Effects of sugarcane bagasse ash on the properties of concrete. Proceedings of the Institution of Civil Engineers - Engineering Sustainability 171(3), 123–132 (2018).

[7] Goyal, A., Kunio, H., Hidehiko, O. & Muhammad, A., 2009. Processing of Sugarcane Bagasse Ash and Reactivity of Ash-blended Cement Mortar. *Transactions of the Japanese Society of Irrigation, Drainage and Rural Engineering,* Issue 261, pp. 11-19.

[8] Janjaturaphan, S., Wansom, S.: Pozzolanic activity of industrial sugarcane bagasse ash. Suranaree J. Sci. Technol. 17(4), 349-357 (2010).

[9] Cordeiro, Guilherme & Toledo Filho, Romildo., Fairbairn, E.M.R.: Ultrafine sugar cane bagasse ash: High potential pozzolanic material for tropical countries. 3, 50-67 (2010).

[10] FAOSTAT.: Food and Agriculture Organisation of The United Nations Statistics Division, Crops Production. (2018).

[11] Soobadar, A., Ng KeeKwong, K.F.: Disposal of Heavy Doses of Coal/Bagasse ash in Sugar Cane fields in Mauritius. Research Week. (Online).

[12] Available at: https://www.google.mu/url?sa=t&rct=j&q=&esrc=s&source=web&cd=7&cad=rja&uact=8&ved=0ahUKEwiu3vmrkonUAhVMbRQKHf8UBVEQFghDMAY&url=http%3A%2F%2Fvcampus.uom.ac.mu%2Fresearchweek%2Frw08%2Fabstracts%2F5sep2008%2Fabstract217.doc&usg=AFQjCNG00eO200EiLqBOntNL7zVEE-tfYA[Accessed 25 February 2020]

[13] L. I. M. Castleden, L.I.M., Hamilton-Patterson, J.L.: Bagassosis. An Industrial Lung Disease. British Medical Bulletin. 2, 478-480 (1942).

[14] Ganesan, K., Rajagopal, K., K.Thangavel: Evaluation of bagasse ash as supplementary cementitious material. Cement & Concrete Composites. 29, 515-524 (2007).

[15] Chusilp, N., Chai, J., Kraiwood, K.: Utilization of bagasse ash as a pozzolanic material in concrete. Constr Build Mater 23, 3352-3358 (2009).

[16] Rukzon, s., Chindaprasirt, P.: Utilization of bagasse ash in high-strength concrete. Materials and Design. 34, 45–50 (2014).

[17] Zareei, S. A., Ameri, F., Bahrami, N.: Microstructure, strength, and durability of eco-friendly concretes containing sugarcane bagasse ash. Construction and Building Materials, 184, 258–268 (2018).

[18] Rajasekar, A., Arunachalam, K., Kottaisamy, M., Saraswathy, V. : Durability characteristics of Ultra High Strength Concrete with treated sugarcane bagasse ash. Construction and Building Materials.171, 350–356 (2018).

[19] Cordeiro, G. C., Andreão, P. V., Tavares, L. M.: Pozzolanic properties of ultrafine sugar cane bagasse ash produced by controlled burning. 5(10) (2019).

[20] Praveenkumar, S., Sankarasubramanian, G.: Mechanical and durability properties of bagasse ash-blended high-performance concrete. SN Applied Sciences, 1(12) (2019).

[21] Singh, D., Jain, S.: 2019. Experimental Study of Bagasse Ash as a Cement Replacing Material. International Research Journal of Engineering and Technology. 6(6), 2246-2254 (2019).

[22] Quedou, P. G., Hoolaus, H., Ramdhony, Y.: Experimental Study of Sugarcane Bagasse Ash as a supplementary Cementitious Material in Concrete. International Journal of Enhanced Research in Science, Technology & Engineering. 7(10), 12-17 (2018).

[23] Islam, A., Yesmin, R.: Mechanical Properties of Sugarcane Bagasse Ash (SCBA) as a Partial Replacement of OPC. International Journal of Research Publication. 39(2) (2019).