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Experimental Study on Performance of Sugarcane Bagasse Ash in SCC (Self Compacting Concrete): A Review

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Abstract: *Self-compacting concrete (SCC) has the ability to creep and self-compact. One of the benefits of SCC can reduce construction time and labor costs. The materials to be used are slightly different from conventional concrete. Cement is the most important component of concrete mix for construction works and cement is the second most consumed material in the world after water. However, we are aware that this leads to major environmental damage as the cement production process reduces carbon dioxide. The objective of this research is to determine the mechanical properties and workability of sugarcane bagasse ash (SCBA) as a partial addition to ordinary portland cement (OPC) in concrete. SCC was partially added in percentages of 5%, 10%, 15% and 20% by weight of cement for an average target strength of 27 MPa. To evaluate the behavior of self-compacting concrete on concrete, various tests were carried out on concrete samples, namely compressive strength test, slump cone test, V-funnel test, L-box test. The study concluded that 10% replacement of OPC SCBA showed positive results and can be considered as a suitable cementitious material in the construction industry.*

Keywords: Conventional concrete, Compressive strength, Self-compacting concrete, Sugar cane bagasse ash (SCBA), Cement, slump cone test, V-funnel test, L box test

I. INTRODUCTION

Concrete is an essential part of building systems. We could not imagine the construction without concrete. It is becoming the world's backbone for infrastructure growth. Concrete has been and will be the most versatile material used in construction for many years. Concrete has an advantage over other building materials primarily due to its unique ability to take any shape in a variety of applications, whether it is produced on site or manufactured in a factory as a precast product.

We are aware that the production of cement causes great damage to the environment. It involves a lot of carbon emissions associated with other chemicals. Research has shown that every one ton of cement production releases half a ton of carbon dioxide, so there is an immediate need to control the use of cement. Ordinary Portland cement is the most commonly used construction material worldwide and will maintain its position in the near future due to the demand and expansion of the construction industry worldwide. On the other hand, it is difficult to dispose of waste materials such as sugarcane ash, which in turn is hazardous to the environment. Bagasse ash gives high initial strength to concrete and also reduces the permeability of concrete. Silica present in Bagasse fly ash reacts with cement components during hydration and imparts other properties to it like chloride resistance, corrosion resistance etc. Thus, the use of Bagasse fly ash in concrete not only reduces environmental pollution but also improves the properties of concrete. reduces costs. This makes the concrete more durable.

In this situation, research began on a cheap and easily available alternative material to cement. Considerable amounts of industrial waste or by-products accumulate in developing countries every year. A very large amount of energy is needed to produce cement and concrete. By using industrial by-products, the adverse effects of concrete can be minimized by producing good and durable concrete. The main agricultural industry in India is sugar processing. Environmental protection initiatives in terms of environmental pollution as well as protection and management of

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natural areas, management of by-products, residues and industrial waste need to be managed and monitored worldwide. Agro-waste is used as a construction material in the concrete mix. Agricultural waste, also called agricultural waste, such as rice husk ash, wheat straw ash, hazelnut shells, and sugarcane bagasse ash are used as pozzolanic materials for the development of concrete and mortar. Sugarcane which is the main crop grown in more than 110 countries and the total production of sugarcane is more than 1500 million tons. The total production of sugarcane in India is over 300 million tons per year. This processing of sugarcane in the sugar factory generates about 10 million tons of sugarcane bagasse ash as waste material. Approximately 26% bagasse and 0.62% residual ash can be obtained from one ton of sugar cane. After combustion, the residue has a chemical composition dominated by silica

Currently, efforts have been made to utilize the vast amount of Bagasse, the residues of the in-line sugar industry. It also provides amorphous silica ash that has pozzolanic properties when this waste is incinerated under controlled conditions. Therefore, sugarcane bagasse ash (SCBA) can also be used as a cement replacement material to improve the consistency and reduce the cost of building materials such as mortar, concrete tiles and concrete roof tiles.

Self-compacting concrete was first developed in 1988 to achieve durable concrete for construction work by improving the quality of construction processes. SCC finds special application in construction work in some places, such as highly reinforced columns of the construction work, overloaded reinforced sections, rafts and places where ordinary vibrated concrete or conventional concrete is not effectively used. According to recent studies conducted on self-compacting concrete, researchers have concluded that self-compacting concrete will replace regular vibrated concrete or conventional concrete in the near future. Therefore, self-compacting concrete can also be called future concrete. Self-compacting concrete is where the concrete can be placed and compacted by its own weight, meaning no external force other than gravity is required to deposit this type of concrete. For this reason, self-compacting concrete can be placed in each corner of the formwork without the effect of vibrations that do not cause segregation. According to the researchers in the previous studies they conducted, the modulus of elasticity for the studied cases has a high value, so it proves that SCCs are not too deformable, so they can be used for precast structures with large spans. SCC is the way forward for both in-situ and prefabricated buildings.

II. LITERATURE REVIEW

In recent years, many studies have been conducted by various researchers on self-compacting concrete with replacement cement. The aim expected from the paper is to gather recent innovations in self-compacting concrete using sugarcane bagasse ash, study their effect on concrete properties and create international benchmarking for further research work in this regard

In this study, N. H. M. K. Serker presented a paper on “Development of Self-Compacting Concrete Using Sugarcane Bagasse Ash”in this study Sugarcane Bagasse Ash (SCBA) is one kind of waste which can be termed as the residue left over from burning sugarcane bagasse. Chemical test of SCBA shows that bagasse ash contains significant amount of silica which can be used as pozzolanic materials in concrete. Self Compacting Concrete (SCC) was developed in this paper using SCBA as a partial replacement of cement. Upto 20% cement was partially replaced by SCBA to check the effect on workability and compressive strength of SCC. The experimental results show that the SCC produced using SCBA fulfills the required qualities such as filling ability, passing ability and segregation resistance of fresh SCC and also no water bleeding was occurred. Compressive strength test result of 28 days shows that when cement was partially replaced with SCBA upto 5% in SCC, concrete gain compressive strength close to 90% of target strength and also 5% cement replaced with SCBA in SCC, concrete gain more than 66% of target strength at 7 days.

Shazim Ali Memon has presented paper on, “Use of Processed Sugarcane Bagasse Ash in Concrete as Partial Replacement of Cement: Mechanical and Durability Properties”, Using biomass waste as supplementary cementing material (SCM) in concrete has attracted researchers’ attention for efficient waste utilization and reducing cement demand. Sugarcane bagasse ash (SCBA) is one such example of biomass waste. It is an agricultural waste obtained when sugarcane bagasse from the sugar industry is used for power generation and disposed of in open-air dumping sites. Its waste disposal causes the generation of particulate matter, degrading air quality. In this study, the effect of processed SCBA as SCM in concrete has been investigated. The processing of the SCBA involved the removal of fibrous and carbon-containing particles by sieving followed by grinding. The SCBA was ground for 45 min until the surface area was comparable to that of cement and was then used for further characterization and incorporation into

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concrete. The 45 min grinding time resulted in 2.92 times higher pozzolanic reactivity of the SCBA. The SCBA was incorporated by replacing cement in different weight fractions (10%, 20%, 30%, 40%) in concrete. Test results showed that the concrete workability increased with SCBA incorporation, whereas the resulting concrete density was reduced. The results of the mechanical properties, including compressive sstrength and hardened density, were enhanced upon the cement replacement by SCBA. Concrete containing 30% SCBA can be used for structural applications as its 28 days compressive strength was 21 MPa, which complies with ACI 318-16 specifications. Concrete resistance against scaling and leaching due to adverse effects of sulfuric and hydrochloric acid considerably increased with SCBA addition and was due to microstructure densification by secondary hydrates formation as lower portlandite content was detected by thermogravimetric analysis. Hence, SCBA processing increases its reactivity, as reflected by the improved mechanical properties and greater durability of SCBA-incorporated concrete.

Duc-Hien Le has presented paper on, "Fresh and hardened properties of self-compacting concrete with sugarcane bagasse ash–slag blended cement", This study focuses on combined usage of agro and industrial wastes in developing environment-friendly concrete. Fresh and hardened characteristics of self-compacting concrete (SCC) made of blended cement with sugarcane bagasse ash (SBA, an agro-waste generated during sugar manufacture), granulated blast furnace slag (BFS) and Ordinary Portland cement were examined through an experimental program. Three SCC mix groups (BA10, BA20, and BA30) corresponded with three cement replacing levels of SBA (10%, 20%, and 30%) were developed. For each group, four mixtures associated with four replacement ratios of cement by slag were further employed (0%, 10%, 20%, and 30%). Totally, 12 mixtures incorporating SBA and BFS blended-cement and one reference mix were developed for experiment. Fresh properties of the proposed SCC were evaluated through measurement of the density, slump, slump-flow, V-funnel test, T500 slump, Box-test, and setting time. In addition, testing of compressive strength, ultrasonic pulse velocity, sulfate attack, water absorption as well as electrical resistivity were conducted for hardened concrete. The testing results indicated that replacing either SBA and/or BFS to OPC in mixtures led to lesser flow ability. Compressive strength of sample made of 30% SBA and 30% BFS substituting to OPC were comparable to that of control after 91 days. Moreover, both of SBA and BFS strongly enhanced sulfate attack resistance; and almost SCC samples had a negligible corrosion rate after 28-day ages.

Neha G. Deshmukh , P. O. Modani has presented paper on "Durability Studies on Concrete Using Sugarcane Bagasse Ash", Sugarcane bagasse is a fibrous by-product of the sugar refining process. This by-product causes a high level of environmental pollution, necessitating the use of urgent waste disposal methods. The present study focuses on the use of Sugarcane Bagasse Ash in a concrete production as a substitute material for fine aggregate. The use of fine aggregate in concrete is increasing day by day. Sugarcane Bagasse ash contains a high amorphous silica and aluminium content. In the present analysis, agricultural waste product Sugar Cane Bagasse Ash (SBCA) is used as an alternative binding material. The aim of this project is to investigate the effects of partially replacing fine aggregate with sugarcane bagasse ash in concrete that has been exposed to various curing environments. The bagasse ash used for the research work is collected from Mahatma Sugar Factory, Wardha and used in concrete as a fine aggregate replacement in the ratio of 0 %, 5%, 10%, 15% & 20% by a weight. The influence of a fine aggregate replacement by bagasse ash on durability of concrete to Acid attack and Sulphate attack is determined in this paper. The concrete specimens were cured for 28 days in a solution of 3% sulphuric acid and hydrochloric acid. In this paper, we primarily focus on evaluating variation in compressive strength and weight reduction in five different M30 Grade mixes.

Sagar Dhengare has presented paper on, "Fineness Effect of Sugarcane Bagasse Ash, Rice Husk Ash, and Fly Ash on Strength of Concrete", in this paper is carried out to study the utilization of fly ash in cement concrete as a partial replacement of cement. The Bagasse ash imparts high early strength to concrete and also reduce the permeability of concrete increases the durability of concrete. Rice husk ash is an agricultural based pozzolanic material, generated by rice mills in huge quantities. Therefore the use of ashes in concrete not only reduces environmental pollution but also enhances the properties of concrete and also reduces the cost. This paper summarizes the research work on the properties of Sugarcane Bagass , Rice Husk Ash, and Fly Ash when used as a partial replacement for Ordinary Portland Cement (OPC-53) in concrete. OPC was replaced with ashes by weight at 15% at various fineness passing through IS sieves 150, 300 and 600 micron.0% replacement served as the control. Workability test was carried out on fresh concrete while Compressive Strength Test was carried out on hardened 150×150×150 mm concrete cubes after 7, 28, 56 and 90 curing in water. The results were compared to controlled sample.

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Lavanya M.R has presented paper on , studied the feasibility of using sugarcane Bagasse Ash (SBA), a finely ground waste product from the sugarcane industry, as partial replacement for cement in conventional concrete is examined. The tests were conducted as per Bureau of Indian Standards (BIS) codes to evaluate the suitability of SBA for partial replacements up to 30% of cement with varying water cement (w/c) ratio. The physical properties of SBA were studied. Compressive strengths (7, 14 and 28 days) were determined. The results showed that the addition of sugarcane bagasse ash improves the strengths in all cases. The maximum strength increase happens at 15% with 0.35 w/c ratio.

Jijo James, P. Kasinatha Pandian has presented paper on "A Short Review on the Valorisation of Sugarcane Bagasse Ash in the Manufacture of Stabilized/Sintered Earth Blocks and Tiles", this paper aims at reviewing the valorisation of sugarcane bagasse ash in the manufacture of stabilized as well as sintered earth blocks. Sugarcane bagasse ash is a silica rich material that can play the role of an effective pozzolan leading to enhanced pozzolanic reactions resulting in better performing building materials. The reviewed literature reveals that it has been utilized in the manufacture of blocks as well as tiles in the form of an auxiliary additive as well as a primary stabilizer. However, its utilization in stabilized blocks has been more common compared to sintered blocks due to higher energy consumption in the latter. To summarize, sugarcane bagasse ash not only has improved performance in most of the cases but also has reduced the cost of the material, leading to the conclusion that its valorisation in manufacture of blocks and tiles is a genuine and highly productive solution for waste management as well as cost economy.

T. S. Abdulkadir has presented paper on, “Evaluation of Sugarcane Bagasse Ash as a Replacement for Cement in Concrete Works” studied the suitability of SCBA as a partial replacement for cement in concrete productions. Chemical test was conducted on SCBA to evaluate its percentage composition. It was then used to replace OPC by weight in ratio of 0%, 10%, 20% and 30%.The cubes were tested at 7, 14, 21 and 28days of curing ages for density and compressive strength. 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. 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.

A. A. Dayo (2019) has presented paper on the main focus of this research work was to examine the fresh property and mechanical (compressive strength and splitting tensile strength) concrete properties by replacing 0%, 10%, 20%, 30% and 40% of SCBA by dry weight of fine aggregates. A total of 60 concrete cylinders were prepared with 1:2:4 proportion with 0.50 water-cement ratio and immerged in water on 7 and 28 days. Finally, these concrete cylinders were tested on UTM. Three concrete samples were cast for each proportion and ultimately the average of the three concrete samples was taken as the final result. The slump value of concrete decreased with increases in amount of SCBA in cement concrete. The result analysed that the compressive and tensile strength of the concrete samples increased by 7.90% and 14% at 10% of SCBA as sand substitute materials in cement concrete after 28 days.

Eduardo M.R. Fairbairn has ptesented paper on, in this paper presents a study of cement replacement by sugarcane bagasse ash (SCBA) in industrial scale aiming to reduce the CO2 emissions into the atmosphere. SCBA is a by-product of the sugar/ethanol agroindustry abundantly available in some regions of the world and has cementitious properties indicating that it can be used together with cement. Since one of the key variables to estimate the CO2 emissions is the average distance between sugarcane/ethanol factories and the cement plants, a genetic algorithm was developed to solve this optimization problem. The results indicated that SCBA blended cement reduces CO2 emissions.

III. CONCLUSION

The following conclusions were drawn from the literature study and discussion:

- In this study SCC was developed using SCBA as partial replacement of cement upto 20%.
- Concrete mixes up to 5% addition of bagasse ash have shown good slump flow.
- The results show that when SCBA was used as a partial cement replacement in concrete up to 10%, the compression strength was significantly higher.

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- It was observed that 20% addition of SCBA provides a lower compressive strength compared to 5%, 10% and 15% of SCBA at 28 days. Thus it is found that adding SCBA at a high doseof over 10% of cement would not produce expected strength and would not be practically applicable.

IV. ACKNOWLEDGMENT

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