Study on Compressive Properties of Partial Replacement of Cement in Mortar by Sugarcane Bagasse Ash

Ariba K. Hamidi, Amit R. Nishad, Rahul R. Patle

Abstract: ***As the increase in demand for construction material goes on increase, it becomes difficult to fulfill such amount of supply of construction materials also causing increase in their rate respectively. To overcome such a problem the main focus of researchers is to utilizing industrial or agricultural waste materials as a raw material which replaces the quantity of cement. Utilization of these wastes will not only be economical but also results in environmental pollution control. Some of the industrial waste materials are blast furnace slag, fly ash and silica fume which are being used as supplementary cementing materials. On the other hand, Sugar cane bagasse ash is a fibrous waste product of the sugar industry. This waste product is already causing serious environmental pollution, which results in urgent solution of disposal. Here bagasse ash is mainly contains aluminum ion and silica which can be used as an alternative binding material. In this research paper the bagasse ash powder used is obtained from Purti Power plant (Bela) and sieved through 90 micron IS sieve size. Bagasse ash is partially replaced with ordinary Portland cement in the ratio of 0%, 5%, 10%, 15%, 20% and 25% by weight in mortar. The properties of fresh mortar like compressive strength are determined after 7 days, 14 days and 28 days for M10 mix. It has been found that the replacement of cement by sugarcane bagasse ash can be effectively utilized for the purposed like plastering, filling the space between bricks, footway, etc.***

Keywords*: Bagasse Ash, Compressive Strength, Replacement of Cement, Mortar, Ordinary Portland Cement*

I. INTRODUCTION

India alone generates approximately 90 million of bagasse as a solid waste from the sugarcane industry. Disposal of solid waste generated from industrial production activity is the other serious problem. The accumulation of wastes is not only a burden to the industry, but also affects the environment adversely. Ordinary Portland cement is the most extensively used construction material in the world. Since the early 1980's, there has been an enormous demand for the mineral admixture and in future this demand is expected to increase even more. Also in this modern age every structure has its own intended purpose and hence to meet this purpose modification in traditional cement concrete has become essential. This situation has led to the extensive research on concrete resulting in mineral admixture to be partly used as cement replacement to increase workability in most structural application.

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If some of raw material having similar composition can be replaced by weight of cement in concrete then cost could be reduced without affecting its quality. A few studies have been carried out on the ashes obtained directly from the industries to study pozzolanic activity and their suitability as binders, partially replacing cement.

The present study was carried out on SCBA obtained by controlled combustion of sugarcane bagasse, which was procured from the Maharashtra in India. Sugarcane production in India is over 300 million tons/year leaving about 10 million tons of as unutilized and, hence, wastes material. This paper analyses the effect of SCBA in concrete by partial replacement of cement at the ratio of 0%, 5%, 10%, 15%, 20%, and 25% by weight. The main ingredients consist of Portland cement, SCBA, crushed sand, coarse aggregate and water. After mixing, concrete specimens were casted and subsequently all test specimens were cured in water at 7, 14 and 28 Days.

II. OBJECTIVES OF STUDY

The main objective of this research was to determine the effectiveness of sugarcane bagasse ash (SCBA) as cement replacement material in mortar. To study the different strength of hardened mortar such as compressive strength of mortar cubes at 7 days, 14 days and 28 days.

To increases the usage of waste product for the purpose of commercial work. To control the adverse effect of pollution because of disposal of waste (bagasse ash).

III. LITERATURE REVIEW

Many researchers from various countries have made experimentation in utilizing the SCBA as replacement materials in concrete mostly replacing cement and few on fine aggregate.

R Shrinivasan and K. Sathiya (2010) studied on "Experimental Study on Bagasse Ash in Concrete". The utilization of industrial and agricultural waste produced by industrial processes has been the focus of waste reduction research for economic, environmental, and technical reasons. Sugar-cane bagasse is a fibrous waste product of the sugar refining industry, along with ethanol vapor. This waste product (Sugar-cane Bagasse ash) is already causing serious environmental pollution, which calls for urgent ways of handling the waste. Bagasse ash mainly contains aluminum 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 test result indicate that the strength of concrete increase up to 15% SCBA replacement with cement.

Piyush kumar & Anil Pratap Singh (2015) studied on "Effect of use of Bagasse Ash on Strength of Concrete", with increasing demand and consumption of cement, researchers and scientist are in search of developing alternate binders that are ecofriendly and contributes towards waste management. In these paper SCBA has been chemically and physically characterized and partially replaced in the ratio of 0%, 5%, 10%, 15% & 20% by weight of cement in concrete.

Sagar W. Dhengare, Dr. S.P. Raut, N.V. Bandwal, Anand Khangan (2015) Studied on, "Investigation into Utilization of Sugarcane Bagasse Ash as Supplementary Cementations Material in Concrete". This paper presents the use of sugarcane bagasse ash (SCBA) as a pozzolanic material for producing high-strength concrete. The utilization of industrial and agricultural waste produced by industrial processes has been the focus on waste reduction. Ordinary Portland cement (OPC) is partially replaced with finely sugarcane bagasse ash. The concrete mixtures, in part, are replaced with 0%, 10%, 15%, 20%, 25% and 30% of SCBA respectively. In addition, the compressive strength, the flexural strength, the split tensile tests were determined. The bagasse ash was sieved through No. 600 sieve. The mix design used for making the concrete specimens was based on previous research work from literature. The water – cement ratios varied from 0.44 to 0.63. The tests were performed at 7, 28, 56 and 90 days of age in order to evaluate the effects of the addition SCBA on the concrete. The test result indicate that the strength of concrete increase up to 15% SCBA replacement with cement.

Jaymin Kumar, A. Patel, Dr. D. B. Raijiwala (2015) studied on, "Experimental Study on Use of Sugar Cane Bagasse Ash in Concrete by Partially Replacement with Cement". In this paper sugar cane bagasse ash which is taken from one of the sugar mill of south Gujarat (INDIA) used in M25 grade of concrete by replacing cement 5% by weight and compare with normal M25 grade of concrete to check the feasibility of sugar cane bagasse ash in concrete.

Srinivasan et al., studied chemical and physical characterization of SCBA, and partially replaced in the ratio of 0%, 5%, 15% and 25% by weight of cement in concrete. Compressive strength, split tensile strength, flexural strength and modulus of elasticity at the age of 7 and 28 days was obtained as per Indian Standards. It was found that the cement could be advantageously replaced with SCBA up to a maximum limit of 10%. Therefore it is possible to use sugarcane bagasse ash (SCBA) as cement replacement material to improve quality and reduce the cost of construction materials such as concrete.

IV. EXPERIMENTAL INVESTIGATION

A. Material Used:

1. Cement- Ordinary Portland cement of 53 grade from a single batch was used for the entire work and care has been taken that it has to been stored in airtight containers to prevent it from being affected by the atmospheric and monsoon moisture and humidity. The cement procured was tested for physical requirements in accordance with IS: 12269-1987 and for chemical requirements in accordance with IS: 4032-1977.
2. Water- Mixing water should not contain undesirable organic substances or inorganic constituents in excessive proportions. In this project clean potable water is used and curing as per IS: 456-2000.
3. Fine Aggregate- The river sand, passing through 4.75 mm sieve and retained on 600 μm sieve, conforming to Zone II as per IS 383-1970 was used as fine aggregate in the present study. The sand is free from clay, silt and organic impurities. The aggregate was tested for its physical requirements such as gradation, fineness modulus, specific gravity and bulk modulus in accordance with IS: 2386-1963.

Sugarcane Bagasse Ash- Sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemicelluloses of lignin. Each ton of sugarcane generates approximately 26% of bagasse (at a moisture content of 50%) and 0.62% of residual ash. The residue after combustion presents a chemical composition dominates by silicon dioxide (sio2). In spite of being a material of hard degradation and that presents few nutrients, the ash is used on the farms as a fertilizer in the sugarcane harvests. In this sugarcane bagasse ash was collected from Purti Power Plant (BELA), Nagpur.

Fig. No.1: Sugar Bagasse ash

Table no. 1: Chemical Properties of Sugarcane Bagasse ash Powder

Description of properties	Percentage (%)
Silica (SiO_2)	66.89
Alumina (Al_2O_3)	29.18
Ferric oxide (Fe_2O_3)	29.18
Calcium Oxide (CaO)	1.92
Magnesium Oxide (MgO)	0.83
Sulphur tri Oxide (SO_3)	0.56
Loss of Ignition	0.72
Chloride	-

V. METHODOLOGY USED

The tests have been performed to determine the mechanical properties were compressive strength of sugarcane Bagasse Ash replaced by the cement.

A. Compressive Cement Test

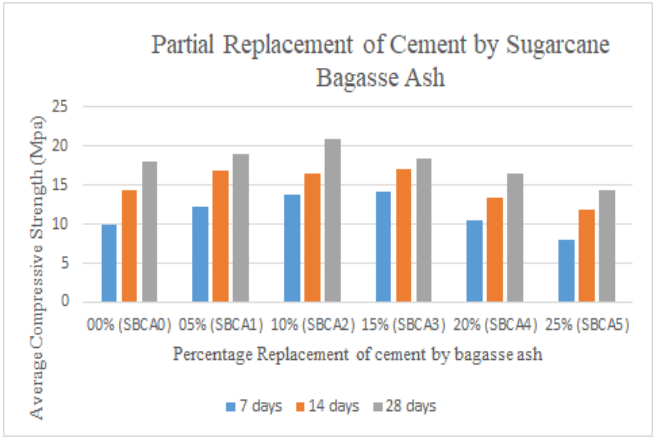
For compressive strength test of cube specimens of dimensions 50 x 50 x 50 mm were used. The Moulds were filled with 0% and 5%, 10%, 15%, 20%, & 25% Sugar Bagasse Ash. Vibration was given to the Moulds using table vibrator to them. The top surface of the specimen was levelled and finished. After 24 hours the specimens were remolded and were transferred to curing tank wherein they were allowed to cure for 7 days, 14 days and 28 days. After 7 days, 14 days and 28 days curing, these cubes are tested on digital compression testing machine as per I.S. 516-1959. The failure load was noted. In each category, four cubes were tested and their average value is reported. The compressive test was calculated as follows:

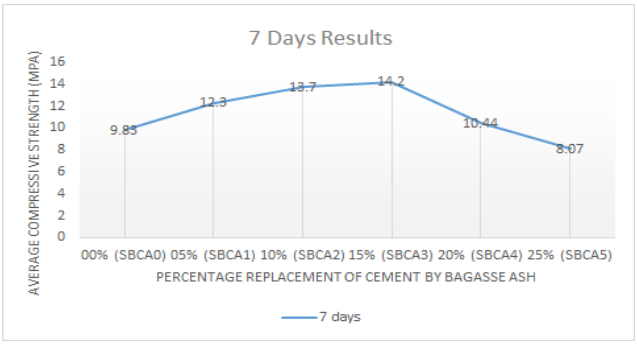
$$\text{Compressive strengrth (MPa)} = \frac{\text{Failure load}}{\text{cross sectional area}}$$

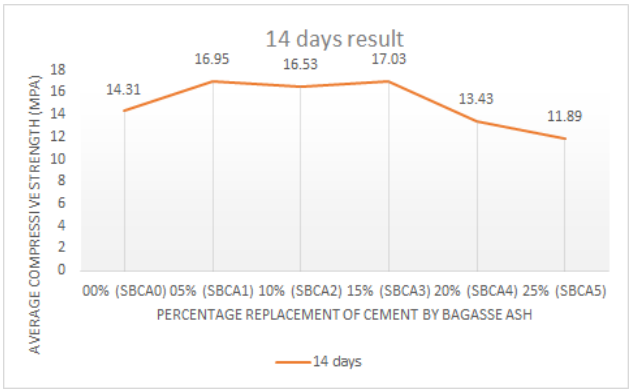
VI. RESULTS AND DISCUSSION

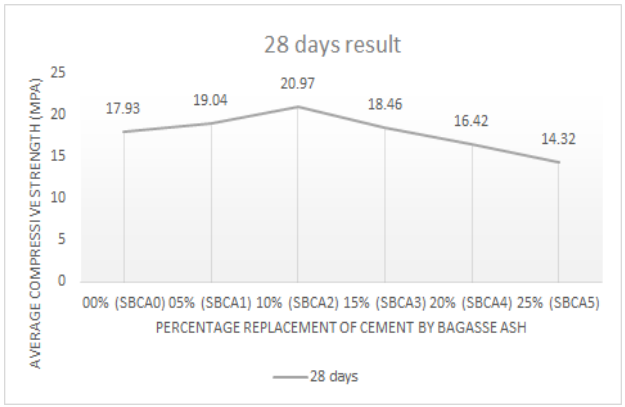
Results of compressive strength for cube specimen with 0%, 5%, 10%, 15%, 20% and 25% Sugarcane Bagasse Ash. The mix design was of M_{10} i.e. 1:3 representing cement and sand along with water cement ratio as **0.5**. Curing was done for 7 days, 14 days and 28 days of Tank Curing.

Days	Average Compression Strength (MPa)					
	0% (SCBA0)	5% (SCBA1)	10% (SCBA2)	15% (SCBA3)	20% (SCBA4)	25% (SCBA5)
7	9.83	12.3	13.7	14.2	10.44	8.07
14	14.31	16.95	16.53	17.03	13.43	11.89
28	17.93	19.04	20.97	18.46	16.83	14.32









VII. CONCLUSION

By analysis of the result the following conclusion can be drawn:

1. The conclusion of the compressive strength of mortar is that at the earlier stages, mortar gets sufficient strength within 7 days.
2. After 10% of replacement the strength of mortar is greater than the result of OPC. It concludes that it is beneficial to use the Bagasse ash as a replacement of cement.
3. It is also observed that there is only slight decrease in result after replacing 25% of cement.
4. It is reliable to use the bagasse ash up to 25% in replacement of cement for the works in which strength is not the main focus such as mortar blocks, plastering, footway, etc.

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