PRELIMINARY INVESTIGATIONS ON THE PARTIAL REPLACEMENT OF CEMENT WITH SUGARCANE BAGGASE ASH

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Abstract: The current paper deals with the preliminary investigations on the use of sugarcane bagasse ash (SCBA) as partial replacement of cement in concrete, resulting in a binary blended concrete. The physical properties of blended cement, such as specific gravity are evaluated. Fresh concrete containing SCBA resulted in a mix with more water demand and hence, lower slump. From the evaluation of nearly 50 cubes and cylindrical specimen for compressive and split tensile strength it was inferred that 10% replacement of SCBA resulted in optimized value of replacement, without affecting the strength parameters of concrete.

Index Terms **: sugarcane bagasse ash, slump, Hardened concrete, binary blended cement**.

1. Introduction

Cement is second most consumable material after the water. Based on recent survey total amount of cement is used during the financial year of 2012 nearly 247 MT and it is estimated increases up to 550 MT for financial year 2020 [1]. India is second largest country after China based on uses of cement.

The production of cement is very costly and it produces large amounts of carbon emissions. Cement manufacture contributes greenhouse gases directly through the production of carbon dioxide when calcium carbonate is thermally decomposed and particularly from the combustion of fossil fuels. The production of one ton of cement produces approximately one ton of CO_2 in the atmosphere [2]. This CO_2 production causes serious environmental damages and it can be prevented by using another binding material or by partial replacement of sand.

1.1 DIFFERENT ALTERNATIVES FOR CEMENT REPLACEMENT

Researcher and Engineers have come out with their own ideas partially replace the use of cement and use recent innovations such as sugarcane bagasse ash, fly ash, bottom ash, blast furnace slag, GGBS (ground-granulated blast-furnace slag), lime, coconut shell ash, marble powder, glass powder, cow dung ash. Now a day's sustainable infrastructural growth requires the alternative material that should satisfy technical requisites of cement as well as it should be available locally with large amount.

Utsev et. al [3] suggested that 10 to 15% partial replacement of OPC with CSA [coconut shell ash] using W/C ratio of 0.5 are suitable for the production of both heavy weight and light weight concrete. Alabadan et. al [4] suggested that there exists a high possibility for partial replacement of cement with Bambara Groundnut shell ash(BGSA) in concrete. Partial replacement of Ordinary Portland Cement with about 10% Bambara Groundnut Shell(BGSA) ash in concrete is acceptable.

Rajamma et al. [5] observed the effects of wood ash on the compressive strength of concrete blocks. Wood ash was used to replace cement in percentages 10%, 20% and 30% by weight of cement, the optimum and significant results were shown on 10% of replacement exhibited higher 28 days strength. Manogna et. al [6] observed that the compression, split tensile and flexural strength of M30 grade concrete increases when the cement is replaced with tile powder up to 30% and further replacement of cement with tile powder decreases the strength gradually. Kumar, P [7] observed that the concrete compressive strength with egg shell powder as cement replacement material increases up to 15 percent.

India is the second largest sugarcane producing country. An annual produce of 341,400000 tonnes was estimated in the year 2013[8]. It is not, however, any wonder that India is one of the largest exporters of sugar worldwide. In India, sugarcane is cultivated for the production of crystal sugar, jaggery (Gur), and numerous alcoholic beverages. It is estimated that the nation's sugarcane industry provides employment for more than 6 million Indian.

The main concern for the sugarcane industry is that they still seeking the solutions for the disposing of wastes generated by the sugar and alcohol production processes. The ash remaining after bagasse is burned is the last residue generated by the sugarcane chain. Each ton of burned bagasse generates 25 kg of ash [9]. The utilization of sugarcane bagasse ash will promote waste management at little cost, reduce pollution by this waste and also sugarcane bagasse ash production required less energy demand compared with cement production.

The main objective of this study is to investigate the suitability of sugarcane bagasse ash as partial replacement for cement in concrete.

2. Materials and Methods

In order to prepare concrete containing SCBA, Portland pozzolana cement (PPC) conforming to IS 1489-2015(part1) [10] was used, the properties of PPC are listed in Table [1]. The fine aggregate used in this investigation is clean sand, whose maximum size is 4.75 mm, conforming to grading zone II, while coarse aggregate confirms to IS: 383-1970[11]. The mix design for M20 grade concrete was prepared following the guidelines of IS 10262-2009 [12] and the ratio was obtained as 1:1.79:3.15 with a water/cement ratio as 0.50. Sugarcane bagasse used in this work was procured from a local sugar industry located in Meerut, UP. The properties such as fineness modulus, water absorption, specific gravity, fineness modulus, water content is found out as per the Indian standard procedure.

Samples for compressive strength, flexural strength and split tensile strengths were prepared as per standard procedure with partial replacements of cement by SCBA at levels of 0%, 5%, 10%, 15% and 20%.

TABLE 1: Physical Test of Cement

PHYSICAL TEST	RESULTS
Consistency	31%
Initial setting time	95 min
Final setting time	315 min
Specific gravity	2.87
Fineness	318m^2/kg

3. RESULTS AND DISCUSSION

The discussions on the results are categorized into three sections. The first section deals with the individual material properties of SCBA, fine and coarse aggregate and cement, while the second section deals with the fresh concrete properties. The third section deals with properties of hardened concrete containing SCBA.

3.1 Specific Gravity: The specific gravity of the blended cement was found to increase with increase in percentage replacement by SCBA as shown in table [2]. It is found that as the amount of SCBA increases the specific gravity of the blended cement decreases due to low density of the former.

TABLE2: Variation of specific gravity

CONTENT	SPECIFIC GRAVITY
100% CEMENT + 0% SCBA	2.650
95% CEMENT + 5%SCBA	2.505
90%CEMENT + 10%SCBA	2.404
85% CEMENT + 15% SCBA	2.310
80% CEMENT + 20% SCBA	2.200
SCBA	1.505

3.2. Fresh concrete properties:

The variation in slump of concrete containing various percentages of SCBA is shown in Fig[1]

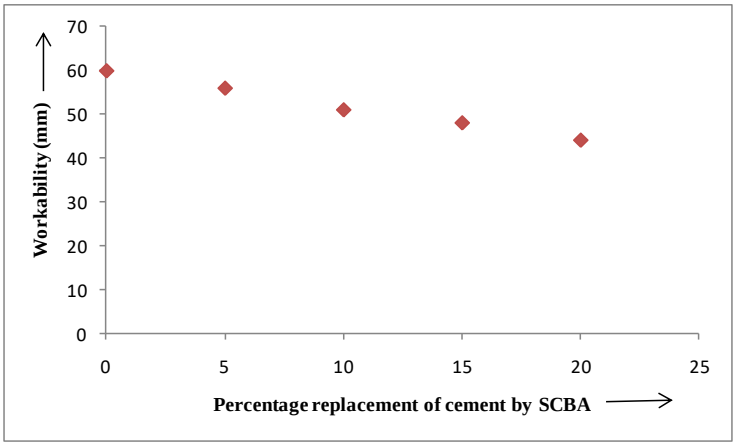

Fig.1 Variation of workability with different percentage of SCBA.

As the amount of SCBA increases, the workability is found to decrease. This is because of the higher water absorption capacity of SCBA, due to which the water demand increases.

3.3 Mechanical Properties:

The mechanical properties of concrete containing SCBA, such as compressive and split tensile are discussed in this section.

3.3.1 Compressive Strength

The variations in compressive strengths of concrete containing various percentages of SCBA is shown in Fig.[2]. It is found that the maximum compressive strength is obtained at 10 percent replacement of cement with SCBA.

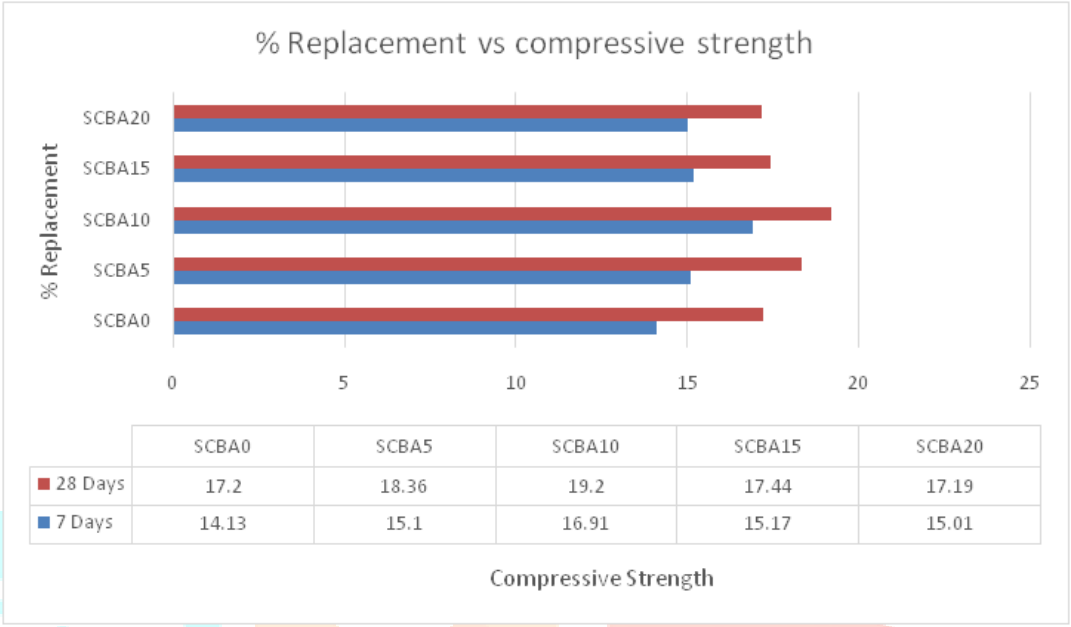

Fig.2 Compressive strength with different percentage of SCBA.

3.3.2. Split tensile strength: The 7 days and 28 days split tensile strength of concrete with varying percentage replacements of SCBA is presented in table [3]. It is seen that as the percentage of SCBA increases, the split tensile strength increases initially up to 10% replacement and then decreases.

Table3: Variation of split tensile strength with percentage replacement by SCBA

% replacement by SCBA	7 days strength	28 days strength
0	1.50	1.75
5	1.56	1.81
10	1.60	1.86
15	1.57	1.78
20	1.53	1.72

Conclusion:

A preliminary investigation on the use of sugarcane bagasse ash as a potential ingredient for partial replacement of cement in M20 grade of concrete is attempted in this work. Based on this work, it is inferred that as the percentage of SCBA increases, the specific gravity of resulting cement decreases. The slump values of fresh concrete are also found to decrease and the compressive and split tensile strength is found to be maximum at 10% replacement. Finally, it could be concluded that SCBA can be effectively used up to 10% replacement of cement without hindering the structural properties of the resulting concrete.

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