Use of Sugarcane Bagasse Ash as Cement Replacement Materials in Concrete

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***Abstract*: In the present era, a number of researchers are using either industrial or agriculture priceless products as a basic source of raw materials for the construction industry. These waste products are economical and helpful in producing a sustainable environment and reducing environmental pollution, which is called handling waste products. It is proposed to study that cement is partially replaced the material of 0%, 5%, 10%, 15% and 20% of Sugarcane Bagasse Ash. In this research, total 60 concrete samples (30 cubes and 30 cylinders) were made water/cement ratio of 0.5 with 1:1:2 mix ratio of concrete and cured after 7, and 28 days. The main purpose of this research study was to observe the indirect tensile strength and compressive strength of concrete blended with various proportions of sugar cane bagasse ash. In this experimental work, for each curing days of 03 cubes and 03 cylinders were cast and finally taken as an average value of three as a final result. The result showed that the indirect tensile strength and compressive strength of concrete made with 10% SCBA increased by 15.40% and 8.50% respectively at 28 days. The workability of concrete is reduced with increases in the amount of SCBA in concrete.**

***Keywords*: Sugar Cane Bagasse Ash, Utilizing Waste Product, Reducing Environmental Pollution, Increasing Strength of concrete.**

I. INTRODUCTION

Concrete is one of the fundamental structural materials widely used in the development of infrastructure throughout the World[1].The importance of concrete in construction industry is increasing day by day since it was innovated [2]. Lomborg (2007) stated that the use of concrete is greater than any other artificial material present on earth [3-4]. It is most abundantly available, inexpensive and durable material that can be converted into different forms and finishes. Generally, concrete mitigates most of the environmental pollutions so it is also used in structures designed for long service life [5]. Concrete is man-made material prepared with ordinary Portland cement commonly used on earth. In this regard, the production of concrete is one of the worldwide despairs, having an impact on environment. Global warming is one the alarming problem created during the manufacture of cement due to release of CO2 in the atmosphere [6, 7]. Since 2005, countries like china manufactured concrete approximately six billion cubic meters per year that consumes the world's cement production of about 40%. The rate of concrete is relatively high due to cost of its main integral, the ordinary Portland cement (OPC) [1]. The consumption of OPC increased from 2 million to 1.3 billion from 1880 up to 1996 respectively, this increment causes most of the environmental problems [8]. However, one ton of CO2 is released in the environment during the manufacturing of one-ton cement [9, 8] and Malhorta reported that cement is the third biggest CO2 instigator [8]. Muga et al. (2005) described that almost 1.6 tons of natural resources are needed for the effective manufacturing of one-ton cement [10, 11].

Cement is a fundamental unit of concrete it does not only create environmental hazards but it's expensive too [1]. Subsequently, cement industries are looking for alternatives instead of using cement in construction in order to avoid environmental problems. A number of researchers have worked as partial cement replacement with industrial as well as agriculture waste product like rice husk ash [12-14], millet husk [15], tile powder [16], fly ash, maize cob ash [17] and many more in order to increase the reinforced concrete structures and decrease the requirement of ordinary Portland cement [18]. These fillers with pozzolanic properties impart nominal merits along with large content of cement replacement to be accomplished [19-25]. The proper usages of these environmental degrading materials will enhance the air quality; reduce the generation of solid waste and the sustainability of the cement and concrete industry. Thus, the purpose of this study, sugar cane bagasse ash is to replace cement in the making of cement concrete.

Bagasse is the main derivative of energy source and sugar mill for sugar making in the same industry [26], while industrially processed sugar. As a raw material for paper production bagasse is used due to its fibrous texture and from one ton of bagasse can produce about 0.3 tons of paper [27]. In Pakistan, around seventy sugar factories create about 14 million tons of bagasse per year, mostly burning bagasse leaves 3% ash used as an energy source, no other uses than landfill [28, 29]. The ash generated during the burning of agricultural waste at a controlled temperature of less than 700 ° C for 1 hour converting the silica content in the ashes to the amorphous phase [30], the specific surface area of the ash is linearly related to the reactivity of amorphous silica.

This research study was conducted on the use of Sugarcane bagasse Ash as a cement substituent material in concrete to determine the fresh and mechanical properties of concrete.

II. MATERIALS & METHODOLOGY

A. Sugarcane Bagasse Ash

Sugar cane bagasse ash was gotten under the burning uncontrolled process of bagasse. The obtained ash is sieved through sieve #300 µm to the desired level of fineness and removes all dirt and larger particles. This sieved ash can be used as a cement replacement material in concrete.

B. Coarse and Fine Aggregate

The aggregates used in research work were locally available in the region of Larkana. Hill sand was used as fine aggregates that passed from #4 sieves and graded to be of zone 2 and the crushed stone used for this research having the size of 20 mm was obtained from Petaro crusher plant. The physical properties of aggregates are given in table 1.

Table 1. Properties of fine and coarse aggregates

Sr. No.	Properties	Fine Aggregates	Coarse Aggregates
01	Fineness Modulus	2.15	--
02	Specific Gravity	2.66	2.62
03	Water absorption	1.75%	1.30%
04	Bulk density (compacted)	116.80lb/ft^3	99.60lb/ft^3

C. Cement

The cement was used as Ordinary Portland Cement (OPC) in this investigational study which is locally available in the region of Larkana

D. Water

Drinkable and clean water was used in this experimental work.

E. Methodology

This experimental work was adopted to determine the fresh (workability) and mechanical properties (compressive and splitting tensile strength) of concrete blended with various proportions such as 0%, 5%, 10%, 15% and 20% of sugarcane bagasse ash as partial replaced of cement in concrete. For this investigational study, two types of standard concrete samples (100x100x100 mm cube and 200x100mm cylinder) were cast in structural concrete laboratory QUEST campus Larkana. A total of 60 concrete samples (30 cylinders and 30 cubes) were cast at a mixing ratio of 1:1:2 with a 0.50 w/c ratio and both types of samples were cured after 7 and 28 days. In this regard, for each curing days, three concrete cubes were tested for compressive strength and three cylinders used for indirect tensile strength of concrete on a universal testing machine (UTM). Finally, the average value for all three samples at each ratio was taken as the final result of a particular test [31].

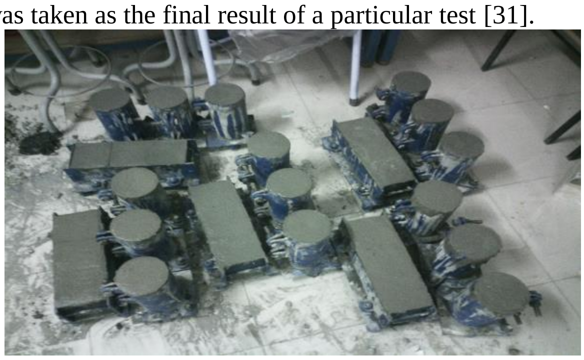

Fig. 1: Casting of concrete cylinders and cubes

III. RESULTS AND DISCUSSIONS

A. Workability of Fresh Concrete

The frustum slump cone was used to measure the workability of fresh concrete in terms of slump reduction. The highest slump value was recorded 54mm in concrete blended with 0% of SCBA and the lowest slump value was measured 26mm at 20% of SCBA as cementitious material in concrete. As percentage of SCBA increases then workability gradually decreases as shown in Fig. 02. This drop-in workability due to the surface area of SCBA is greater than cement; therefore it absorbs some amount of water.

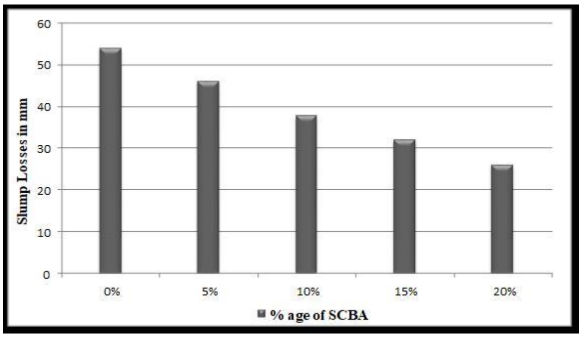

Fig. 2: Workability of Fresh Concrete

B. Compressive Strength of Concrete

The cube specimens were used to determine the compressive strength of concrete. At each proportion of SCBA three cubes were cast and the mean value of three was obtained as an ultimate result. The maximum value of compressive strength was recorded by 23.75 N/mm^2 and 36.93 N/mm^2 by using 10% of SCBA as a substitute for cement in concrete at 7th and 28th days respectively. Similarly, the minimum amount of compressive strength was measured by 19 N/mm^2 and 29 N/mm^2 at 20% of SCBA by the weight of cement after 7 and 28 days respectively as shown in Fig: 3.

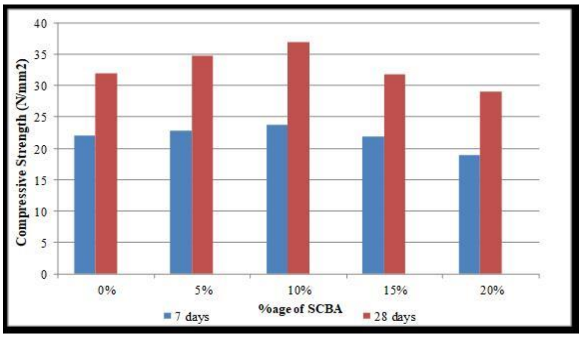

Figure 3: Cubical Compressive Strength of Concrete

C. Splitting Tensile Strength of Concrete

The tensile strength of concrete is evaluated indirectly by using a splitting cylinder method. Total 30 concrete cylinders were cast for splitting tensile strength. At each proportion of SCBA three cubes were cast and the mean value of three was obtained as an ultimate result. The maximum value of indirect tensile strength was measured by 1.95 N/mm^2 and 3.30 N/mm^2 by using 10% of SCBA and minimum amount of compressive strength was reduced by 1.68 N/mm^2 and 2.85 N/mm^2 at 20% of SCBA by the weight of cement after 7 and 28 days respectively as shown in Fig: 4.

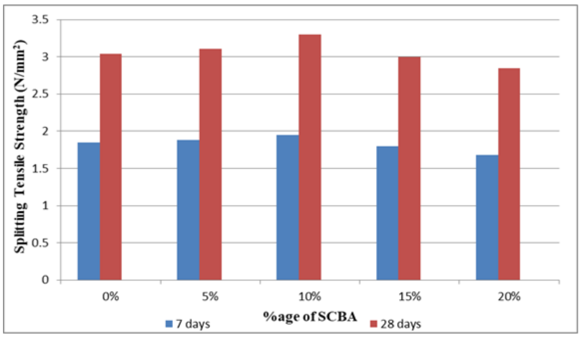

Fig. 4: Splitting Tensile Strength of Concrete

IV. CONCLUSIONS

On the basis of the experimental results obtained in the laboratory, it is concluded that:

- The highest slump value of concrete was recorded by 54mm inclusion with 0% of SCBA and the lowest slump value was measured 26mm at 20% of SCBA as a cementitious material in concrete. It was observed that the amount of SCBA increases then workability of fresh concrete gradually decreases.
- The value of compressive strength was augmented by 7.95% and 15.40% by using 10% of SCBA as a cement substitute material in concrete after 7th and 28th days respectively.
- The amount of compressive strength was decreased by 13.63% and 9.38% at 20% of SCBA as a cement substitute material in concrete after 7th and 28th days respectively.

- The indirect tensile strength was improved by 5.40% and 8.55% by using 10% of SCBA as a cement substitute material in concrete after 7th and 28th days respectively.
- The split tensile strength was reduced by 9.19% and 6.25% at 20% of SCBA as a cementitious material in concrete after 7th and 28th days respectively.

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