USAGE OF SUGARCANE BAGASSE ASH IN CONCRETE

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Abstract—Day to day consumption of cement, developing alternate binders that are ecofriendly and contribute towards waste management is to be initiated. sugarcane bagasse and its ash is one of the agro waste which is a fibrous waste product obtained from sugar mills as byproduct. Usage of sugarcane industry waste such as bagasse and its ash needs to be disposed in appropriate way for solid waste management. The present study was carried out on SCBA obtained by controlled combustion of sugarcane bagasse. Sugarcane production in India is over 300 million tons/year leaving about 10 million tons of as unutilized and, hence, wastes material. This paper analyzes the effect of SCBA in concrete by partial replacement of cement at the ratio of 0%, 5%, 10%, 15% and 20% by weight. The experimental study examines the compressive strength, split tensile strength of concrete. The main ingredients consist of Portland cement, SCBA, river sand, coarse aggregate and water. After mixing, concrete specimens were casted and subsequently all test specimens were cured in water at seven and 28 days for M25 concrete.

Keywords—Cement,Sugarcane bagasse ash, River sand Coarse aggregate, Slump test, Compressive strength test and Split Tensile Strength.

INTRODUCTION

Construction has been an important element in the rapidly changing modern society. Innovation in construction is highly linked with the development of advanced construction materials. Cementitious materials are the major class of construction materials that have been used for several millennia. The ancient cementitious materials were lime alone or lime in combination with natural pozzolanic, as well as gypsum, while the modern ones are largely portland cement. Many countries are in severe shortage of cement, in spite of higher demand. There would be an increase in the use of combination of Portland cement with large contents of mineral additives. Therefore, the search for alternative binder or cement replacement materials has become a technological interest and there is an urgent need to develop newer concrete as a reliable and durable construction material.

From ecological point of view one has

i. To produce binders that consume less energy and emit less greenhouse gases, in particular carbon dioxide.
ii. To incorporate industrial by-products and recycled materials in the cementitious binder as well as in the concrete.
iii. To produce structures that would function more efficiently over time, in terms of their durability performance.

Blended cements are produced by the addition of well-known cement replacement material to ordinary Portland cement. Many of these cement replacement materials or mineral admixtures are industrial wastes. Agricultural wastes such as rice husk ash and sugarcane bagasse ash are also considered as mineral admixtures due to their pozzolanic property.

Currently, there has been an attempt to utilize the large amount of bagasse ash, the residue from an in-line sugar industry and the bagasse-biomass fuel in electric generation industry. When this waste is burned under controlled conditions, it also gives ash having amorphous silica, which has pozzolanic properties. 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. Therefore it might possible to use sugarcane bagasse ash (SCBA) as cement replacement material to improve quality and reduce the cost of construction materials such as mortar, concrete pavers, concrete roof tiles and soil cement interlocking block etc.

MATERIALS USED

Sugarcane Bagasse Ash

The sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemicelluloses and 25% 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 (SiO_2). 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

Table 1: Chemical composition of SCBA

Sr. No.	Component	Mass %
1	Silica (SiO_2)	66.89
2	Alumina (Al_2O_3)	29.18
3	Ferric Oxide ($Fe_2 O_3$)	
4	Calcium Oxide (CaO)	1.92
5	Magnesium Oxide (MgO)	0.83
6	Sulphur Tri Oxide (SO_3)	0.56
7	Loss of Ignition	0.72

Fig 1: specific gravity test of SCBA

Coarse Aggregate:

These are materials passing through 20mm and retained on 16mm, these are generally used in preparation of concrete, as it is a parametric material. Coarse aggregates are used in concrete as they are the reason for strength properties and reduce the shrinkage in concrete.The specific gravity of Coarse aggregates is 2.8

Fine Aggregate:

These are materials with the size less than 2.36mm, these are generally used in preparation of concrete, as it is a parametric material. Fine aggregates are used in concrete as they are the reason for strength properties and reduce the shrinkage in concrete. The specific gravity of Fine aggregates is 2.62

Cement:

It is a material which is used for providing the binding property between the materials of the concrete. It also increases the strength. The specific gravity of cement is 2.79

Water:

In this experimental investigation portable water which is free from organic substances is used for mixing and curing.

EXPERIMENTAL INVESTIGATIONS

In present study, M_{25} grade concrete was designed as per IS: 10262-2009.

E. Workability

Tests performed on the fresh concrete give an idea about the workability of concrete mix. Since pervious concrete is also known as zero slump concrete the slump cone test isn't carried out. Hence in order to determine the workability slump cone test is performed. Freshly mixed concrete were tested for workability by slump value. In this investigation, M_{25} mix concrete is considered to perform the test by weight basis by partially replacing 5%, 10%, 15% and 20%in the weight of cement.

Fig2:Mixing of concrete

F. Compressive Strength

In this investigation, M_{25} mix concrete is considered to perform the test by partially replacing 0%, 5%, 10%, 15% and 20% in the weight of cement. A 150 X 150mm concrete cube was used as test specimen to determine the compressive strength of concrete. The ingredients of concrete were thoroughly mixed till uniform consistency was achieved. The cubes were properly compacted. All the concrete cubes were de-moulded within 24 hours after casting. The de-moulded test specimens were properly cured in water available in the laboratory at age of 28 days. Compression test was conducted with 2000KN capacity on universal testing machine. The load was applied uniformly until the failure of the specimen occurs. The specimen was placed horizontally between the loading surface of the compression testing machine and the load was applied within shock until the failure of the specimen occurred.

Fig 3:Casting and compressive strength testing of cube

C.Split Tensile Strength

In the investigation,M25 mix concrete is considered to perform the test by weight basis by replacing0%, 5%, 10%, 15% and 20% in weight of cement. cylinders having mathematical dimensions of 150mmdiameter and 300mm length were used as test specimen to determine the split tensile strength of concrete .the various ingredients of concrete were mixed thoroughly until uniform consistency was achieved .the cylinders were compacted properly. All the cylinders were de moulded within 24 hours after casting .the de-moulded test specimens were properly cured in water which is available in the laboratory for an age of 28 days .The split tensile strength was conducted as per IS:5816-1976.the specimen was placed horizontally between the loading surfaces of the compression testing machine and the load was applied without any sudden impact until the failure of the specimen occurred.

Fig 4: split tensile strength testing of cylinder

RESULTS AND DISCUSSIONS

E. Workability

Table-2: Slump values for partial replacement of SCBA as cement for M_{25} grade concrete.

Sl. No	% of Cement replaced with SCBA	Slump Value
1	**0%**	76
2	**5%**	78
3	**10%**	80
4	**15%**	81
5	**20%**	82

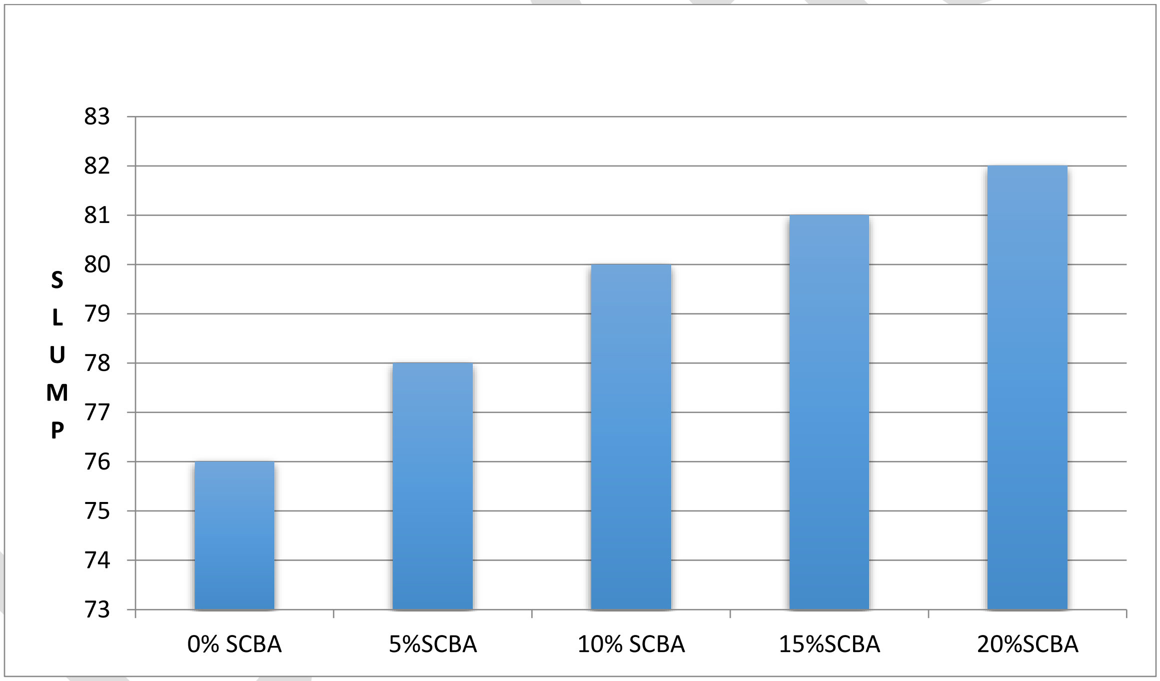

Fig 5 : Slump values for partial replacement of SCBA as cement

F. Compressive Strength Test

The compressive strength test of concrete was achieved in 28 days of various proportions and presented below. The specimens were cast and tested as per IS: 516-1959.

Table-3: Compressive Strength values for partial replacement of SCBA as cement for M_{25} grade concrete.

S.no	Type of Design	Cube no	Weight of each cube (KG)	Reading on dial gauge (KN)	Compressive Strength (N/mm^2)	Average compressive Strength (N/mm^2)
1	Nominal concrete mix	1	8.340	640	28.45	27.70
		2	8.290	510	22.67	
		3	8.140	720	32	
2	5% Replacement of cement	1	7.760	590	26.23	26.45
		2	7.690	530	23.55	
		3	7.720	600	26.67	
3	10% Replacement of cement	1	7.830	370	16.44	17.03
		2	7.710	370	16.44	
		3	7.750	410	18.22	
4	15% replacement of cement	1	7.680	320	14.22	16
		2	7.460	400	17.78	
		3	7.550	360	16.00	
5	20% Replacement of cement	1	7.300	210	9.34	10.97
		2	7.400	280	12.45	
		3	7.230	250	11.12	

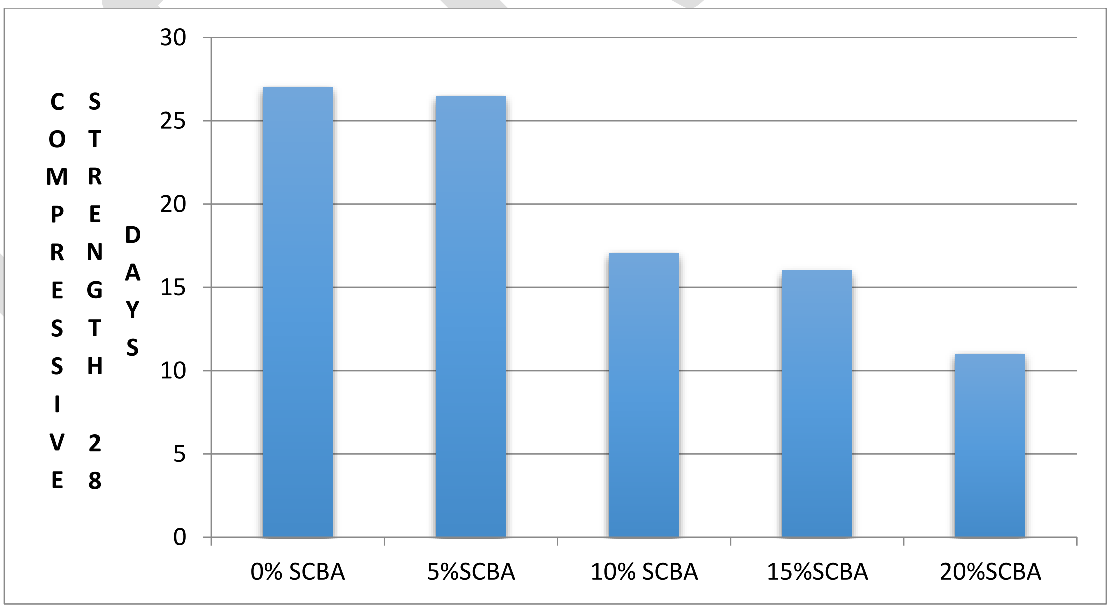

Fig6: Compressive Strengths for partial replacement of SCBA as cement

From the above compressive strength results, it is observed that Rubber based concretes have achieved a decreased in strength for partial replacement of coarse and fine aggregate for 28 days when compared to conventionalconcrete.

C. Tensile Strength Test Values

TheTensile strength test of concrete with 28 days curing period for various proportions and presented below. The specimens were cast and tested as per IS: 516-1959

Table-4: Tensile Strength values for partial replacement of SCBA as cement for M_{25} grade concrete.

S.no	Type of Design	Cube no	Weight of each Cylinder (KG)	Reading on dial gauge (KN)	Split Tensile Strength (N/mm^2)	Average Split Tensile Strength (N/mm^2)
1	Nominal concrete mix	1	12.750	144	2.03	1.94
		2	12.900	139	1.96	
		3	12.360	130	1.83	
2	5% Replacement of cement	1	12.760	135	1.91	1.89
		2	12.610	135	1.91	
		3	12.720	130	1.84	
3	10% Replacement of cement	1	11.950	120	1.7	1.68
		2	12.05	120	1.7	
		3	11.900	115	1.63	
4	15% replacement of cement	1	11.650	110	1.56	1.51
		2	11.400	100	1.41	
		3	11.500	110	1.56	
5	20% Replacement of cement	1	11.250	90	1.27	1.31
		2	11.380	100	1.41	
		3	11.180	90	1.27	

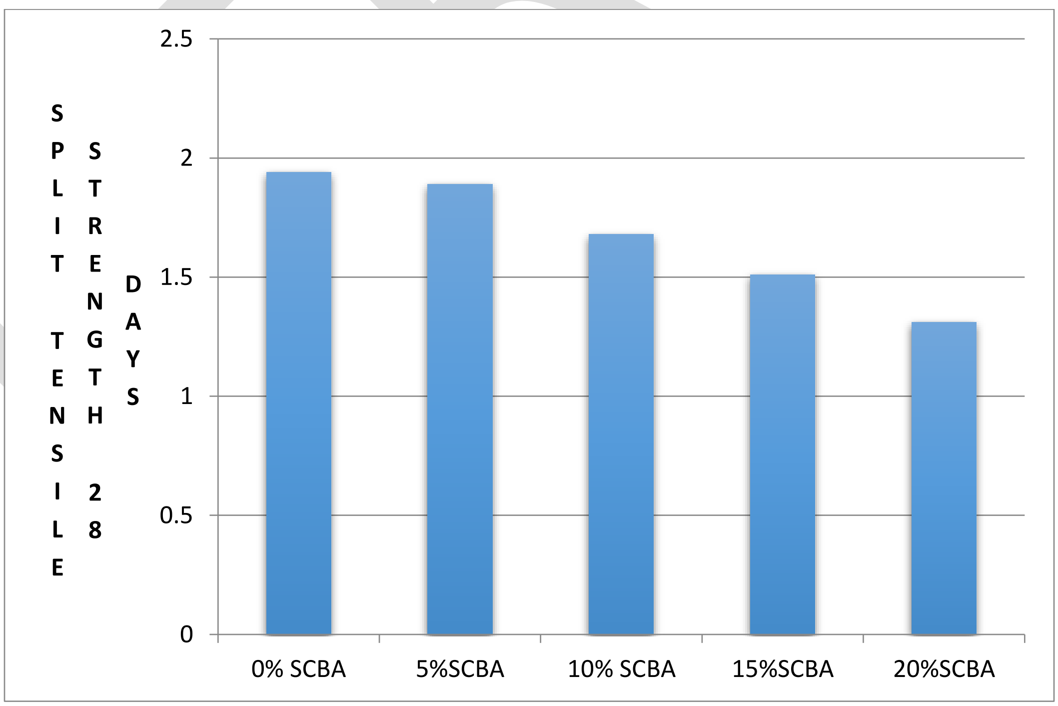

Fig 7: - Tensile strengths for partial replacement of SCBA as cement

CONCLUSION

Based on the experimental results and their plots and subsequent discussion on the results the following conclusions are drawn:

1. Workability of concrete increases by increasing the percentage of replacement of SCBA in concrete.
2. The compressive strength of concrete increased at 5% replacement of cement with SCBA.
3. Further increase in percentage of SCBA results in decrease in compressive strength.
4. The tensile strength of concrete decreasing with addition of SCBA.

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