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Experimental Investigation of Concrete using Sugarcane Baggase Ash as a Partial Replacement for Cement

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Abstract. Cement being a major contributor to carbon emission needs a revolution in its production or modification to the existing cement. One such way to reduce cement usage is to replace the cementitious compound with a suitable material that does not alter the original purpose of cement in concrete. The sugarcane bagasse ashes (SCBA), which are ashes from biomass burning, are found to act as supplementary cementitious material. Moreover, studies were conducted to relate the strength and durability of concrete by the percentage of replacement of sugarcane bagasse ash to cement. The studies revealed that the SCBA imparts more strength to cement at 10% replacement when compared to 20% replacement. However, this study is intended to use 20% of SCBA replacement in cement by adding silica fume. Concrete being mainly reinforced with steel has the problem of corrosion. To overcome the problem of corrosion as well as to reduce the use of cement and to attain the compressive strength of 10% replacement of SCBA. This experiment is intended to analyze the behavior of concrete up to 20% replacement of SCBA with silica fume at different concentrations such as 0%,5%,10%,15%.

Introduction

Utilization of industrial and agricultural waste as source of raw material for the construction of not only encourages sustainable and pollution free environment but also provides the economic situation. One of such fibrous waste product from the sugarcane refining industry is sugarcane bagasse ash. When compared to other types of agro wastes it serves as a best cementitious additive material. The usage of 15 % of SCBA for replacement of cement does not affect the compressive & tensile strength of concrete [1]. Result is such that by replacing 15 % of bagasse ash, high strength concrete can be produced. [2].Silica fume a byproduct of smelting process in the silicon and ferrosilicon industry helps in improving the strength and performance of concrete. It also helps in preventing the reinforcement Steel from corrosion. Adding 15% silica fume increases compressive strength & split tensile strength [3].Adding silica fume in 10% - 20% of cement increases ITZ (interfacial transition zone) around aggregate [4].in this paper we are going to use bagasse ash as a replacement of cement with 20% by altering the amount of silica fume such as 0% ,5% ,10% and 15%.

Material and method

In the study raw materials used are cement fine aggregate natural coarse aggregate sugarcane bagasse and silica fume. Binding material like PPC 53 grade cement of compressive strength 54 N/mm² in 28 days meeting the standard of 12269 2013.Sugarcane bagasse ash is purchase from

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sivagiri and silica fumes is purchased from kangeyam was used as an admixture in cement. Fine aggregate such as river sand from zone 2 grading as per 383 1970 is used.

Table 1: *Properties of cement, SCBA,silica fume*

PARAMETERS	CEMENT	SCBA	SILICA FUME
Specific gravity	3.12	1.94	2.23
Consistency	30%	30%	-
Initial setting (mins)	80	140	-
Fineness modulus	5	-	-
Specific surface (cm2/g)	-	4710	15000-30000

Table 2: *Properties of sand*

PARTICULARS	VALUE
Loose air dried bulk density	-
Moisture content	4.25%
Specific gravity	2.61
water absorption (24HRS)	1.12%
Crushing	-
Impact	-
Fineness modulus	2.52
Bulking	28%
Sieve analysis	Zone II

Table 3: *Mix proportion*

MIXES	% OF SILICA FUMES	w/b	SCBA %	Mix ratio by weight Cement:sand:coarse aggregate
M1	0%conventional concrete	0.45	20%	1:1.5:3
M2	5%	0.45	20%	1:1.5:3
M3	10%	0.45	20%	1:1.5:3
M4	15%	0.45	20%	1:1.5:3

SCBA CONCRETE. SCBA being a good supplementary cementitious material, it is replaced at the rate of 20%.To support high strength of concrete silica fume was added different proportions such as 0%, 5% ,10% ,15% of cement. This concrete is used in load bearing structure.

Experimental methods

Compression test

Compression test are used to find the material properties under load .The compression testing machine gives maximum stress that the specimen can withstand. Here the size of the specimens are of size 150 mm3 SCBA concrete as per is 516:1959. Load at the failure point divided by area provides the compressive strength of concrete.

Fig. 1 compression test

Flexural strength

Flexural strength is one of the measures of tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 100mm cross 100 mm beam with a spanning length of three times the depth. The load is applied and increased gradually until the specimen is fails.

Fig. 2 flexural test

Split tensile test

Split tensile test is the indirect method of testing the tensile strength of concrete which is done by applying load vertically across the diameter of cylinder. The test provides the safety and integrity of the specimen. The dimensions of the specimen are 150mm diameter and 300mm long.

Figure. 3 splitting test

Sorptivity

In order to find sorptivity coefficient water absorption test is carried out. The specimens are preconditioned in the oven at 105 degree Celsius for 24 hours and then cooled down for 24 hours. All the sides of the specimen is covered by an electrician tape to avoid evaporation effect and the opposite sides remains open. Prior to immersion in water the initial weights were recorded. With one side immersed in the water, absorption of water at regular intervals was noted. The sorptivity coefficient is calculated by S=(Q/A) t½.

Results and discussion

Compression strength

The compression strength results for all the mixtures at 7 days and 28 days are given in figure 4. Result proves that the compressive strength of 20% SCBA concrete with 10% silica fume is higher when compared to other mixes. It also indicates the increase of strength of mixtures at later days is due to its pozzolanic properties.

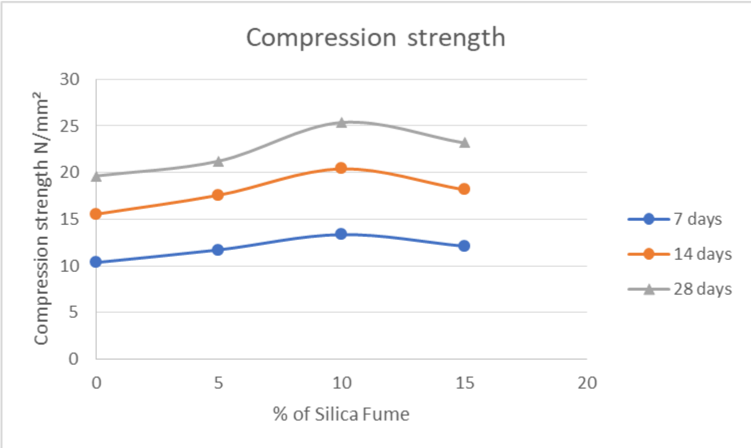

Fig. 4 compressive test of sugarcane bagasse ash concrete

Flexural strength

The flexural strength results for all the mixes at 28 days are given in figure 5. The result shows that 20% SCBA concrete with 10% of silica fume is higher when compared to other mixes.

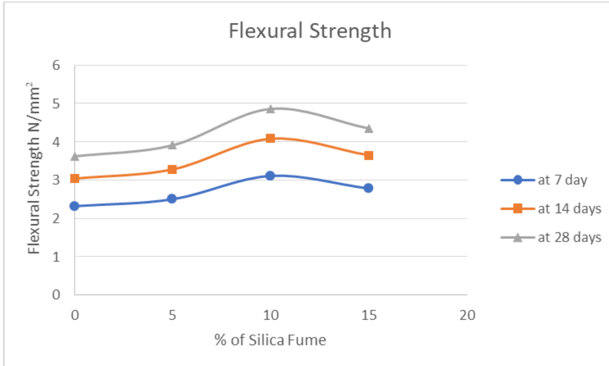

Fig. 5 flexural strength of sugarcane bagasse ash concrete

Tensile strength

The tensile strength result for all the mixes at 28 days are given in figure 6. The strength of mix with 0% silica fume is the highest whereas the mix with 15% is the lowest. The result shows that, when percentage of silica fume increases the tensile strength decreases.

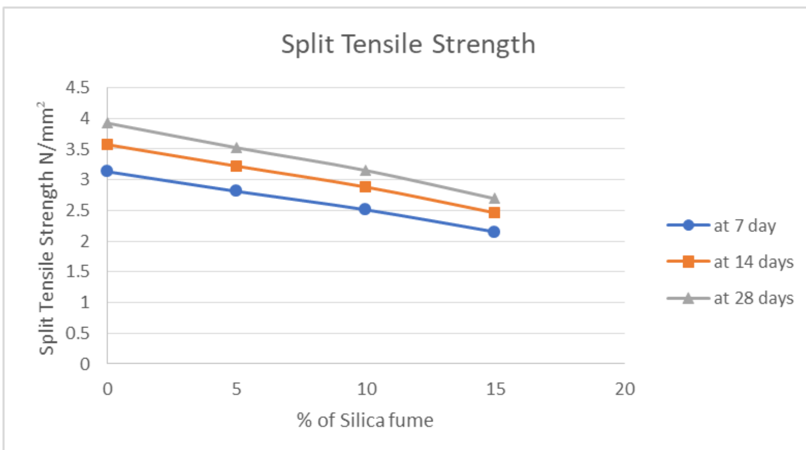

Fig. 6 tensile strength of sugarcane bagasse ash concrete

Sorptivity

The sorptivity results for all the mixtures are given in figure 7. The results show that sorptivity increases as a percentage of silica fume increases. Silica fume being high pozzolanic material it absorbs more water and it is reflected as high sorptivity in results.

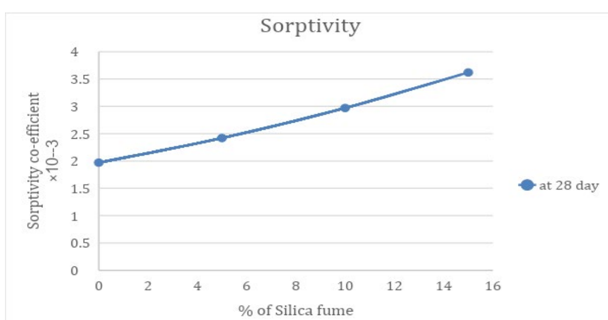

Fig. 7 sorptivity test of sugarcane bagasse ash concrete

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Conclusion

This experimental investigation indicates that the adding silica fume in concrete increases Mechanical properties.

1) While adding 10% of silica fume and 20% SCBA, concrete increases both compressive and flexural strength.
2) Split tensile strength is inversely proportional to percentage of silica fume.
3) Sorptivity is directly proportional to silica fume percentage.

From the above conclusion we can see that adding 10% of silica fume is optimum, which have a direct bearing on durability of concrete

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