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Experimental Investigation on Strengthening of Beams using Retrofitting with Partial Replacement of Cement by Sugarcane Bagasse Ash in Concrete

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Abstract: Concrete is a composite material composed of cement material embedded in a hard matrix of material (the aggregate or binder) that fills the space among the aggregate particles and glues them together. Cement is an important component of concrete. We know the rate of cement is increasing day by day. The aim of the present study is replacing cement in concrete by sugarcane bagasse ash. Sugarcane bagasse ash has been partly used to replace cement in concrete as it contributes beneficial properties to concrete. It improves the strength and durability of concrete. This project is to study the physical and mechanical properties of concrete using sugar cane bagasse at various cement replacements of 0%,5%, 10%, 15%, 20%, 25% with water cement ratio 0.40. In the present work all the beams that are strengthened using externally bonded are expected to withstand higher load compared to the control beam.
Keywords: Sugarcane bagasse ash, Compressive strength, Mechanical properties, Conventional concrete.

I. INTRODUCTION

Cement concrete is the most widely used construction material in any infrastructure development projects. Cost of cement and fine aggregate plays a main role in concrete industry. Many researches were done to replace fine aggregate by using different materials. In this study, we aim to replace cement by using Sugarcane bagasse.

Sugar cane bagasse, the fibrous residue after crushing and juice extraction of Sugar cane, is a major industrial waste product from the sugar industry in India. Now a day, it is common place to reutilize sugar cane bagasse as a biomass fuel in boilers for vapour and power generation in sugar factories. Depending on the incinerating conditions, the resulting sugar National Metal and Materials Technology Centre (MTEC), National Science and Technology Development.

Pozzalanic activity of industrial Sugar Cane Bagasse Ash (SCBA) may contain high levels of sio_2 and Al_2O_3, enabling its use as a supplementary cementitious material (SCM) in blended cement systems. The use of SCBA as an SCM to partially replace ordinary Portland cement not only helps reduce methane emissions from disposal of the organic waste and reduce the production of cement, which is infamous for its high energy consumption and co_2 emission, but also can improve the compressive strength of cement-based materials.

II. MATERIALS

A. Cement

Ordinary Portland Cement most commonly used in general concrete construction where there is no special durability requirement (such as exposure to sulphate attack). In the study OPC of 43 Grade conforming to IS: 8112-1989 was used.

B. Coarse aggregate

Coarse aggregates collected from approved quarry and aggregates having size ranging from 10mm to 20mm are used. The tests are carried out or coarse aggregate as per IS 2386-1968.

C. Fine aggregate

River sand passing through 4.75mm sieve was used. Physical properties of aggregates determined per IS 2386-1968.

D. Water

The water is requierd for preparation of mortar, mixing of cement concrete and for curing work during construction work. The quality and capacity of water has much effect on cement concrete and the strength of mortar in construction work

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E. Sugarcane bagasse ash

SCBA used in this study was obtained by burning SCB at 600oC for 5 hours under controlled conditions and its physical, chemical, and mineralogical characterization was done to evaluate the possibility of its use as binder partially replacing cement in the mortar applications. In this sugarcane bagasse ash was collected in the Sakthi Sugar Factory, located in the city of racecourse road, Coimbatore distic,Tamilnadu.

Fig.1 Sugarcane bagasse ash.

F. Epoxy Resin

The binding property of the resin with concrete and that of FRP is influenced by the type of grade and the environment in which it is retrofitted. It is extremely important that there is a good natured bond, so that the concrete and fibre acts as a composite. The flexural strength of the retrofitted beams largely depends on the composite nature of the element

G. Glass fibers

Glass fibers are commonly used in the naval and industrial fields to produce composites of medium-high performance. Their peculiar characteristic is their high strength. Glass is mainly made of silicon (SiO_2) with a tetrahedral structure (SiO_4). Some aluminium oxides and other metallic ions are then added in various proportions to either ease the working operations or modify some properties (e.g., S-glass fibers exhibit a higher tensile strength than E-glass)

A mat may be made of both long continuous and short fibers (e.g., discontinuous fibers with a typical lengthbetween 25 and 50 mm), randomly arranged and kept together by a chemical bond. The width of such mats varies between 5 cm to 2 m, their density being roughly 0.5 kg/m^3

III. EXPERIMENTAL PROGRAM

A. Concrete Mix

M30 grade concrete mix is designed as per standard procedure using the properties of materials. The water-cement ratio used in the design is 0.5. The mix proportion of material comes out to be 1:1:2(cement: sand: aggregate) and compressive strength of materials after 14 days is 24.3 MPa

B. Methodology

The strengthening of reinforced concrete beam by using glass fibre reinforced polymer sheet has to be studied in the present investigation. Concrete mix of strength M30 has been designed

C. Physical Tests on Concrete

To study the properties of concrete in fresh and hardened state, standard tests has to be conducted. The testing methods of concrete as per IS guidelines has been used for testing concrete specimen.

D. Slump Test

Slump test is intended for measuring workability of concrete shows the slump cone test results of the M30 concrete mix

E. Cube Compression Test

For cube compression testing of concrete, 150mmx150mmx150mm size cubes were used. The cubes were tested at the 28 days of curing by using compression testing machine of 3000 KN capacity

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F. Cylinder split tensile strength

Cylinder split tensile strength tests were carried out on specimens of size 150 mm diameter and 300 mm height at the age of 28 days curing, using compression testing machine of 3000 KN capacity. The wrapping was done on the tested specimens to study the strength-related properties of Glass sheet using epoxy'

IV. RESULTS AND FINDINGS

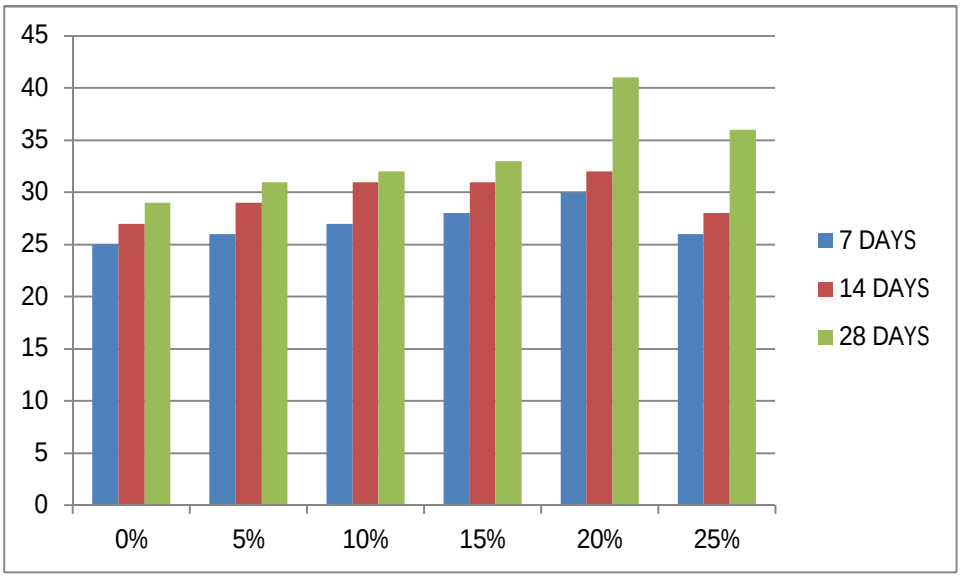
The specific gravity test conducted for cement, coarse aggregates, fine aggregates and tile powder are carried out as per IS2386 using a parameter. Fineness test for fine and coarse aggregate is found out by I.S.SIEVES. The results obtained are mentioned below.

TABLE I
TEST REPORT OF MATERIALS

	Cement	Fine Aggregate	Coarse Aggregate	Sugarcane bagasse ash
Specific gravity	3.15	2.52	2.56	2.18
Fineness	4.33%	4.3%	3.18%	3.34%
Water absorption	-	6.2%	8%	8.23%

TABLE II
COMPRESSIVE STRENGTH TEST ON CUBE FOR 7,14 AND 28 DAYS

MIX %	COMPRESSIVE STRENGTH		
	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
0	25.4	27.6	29
5	26.3	29.6	30.5
10	27	30.5	31.3
15	28.6	31	32.1
20	29.9	31.8	40.3
25	26.8	28.5	35.6



The above chart represents the strength of the cube in 7 days, 14 days, and 28 days for both conventional concrete and replacement of cement in concrete by different ratios of ceramic tile powder. It is observed that if the curing time increases then the strength of concrete is also increases. From the observation the 20% replacement of the Sugarcane bagasse ash gains strength more than the conventional concrete.

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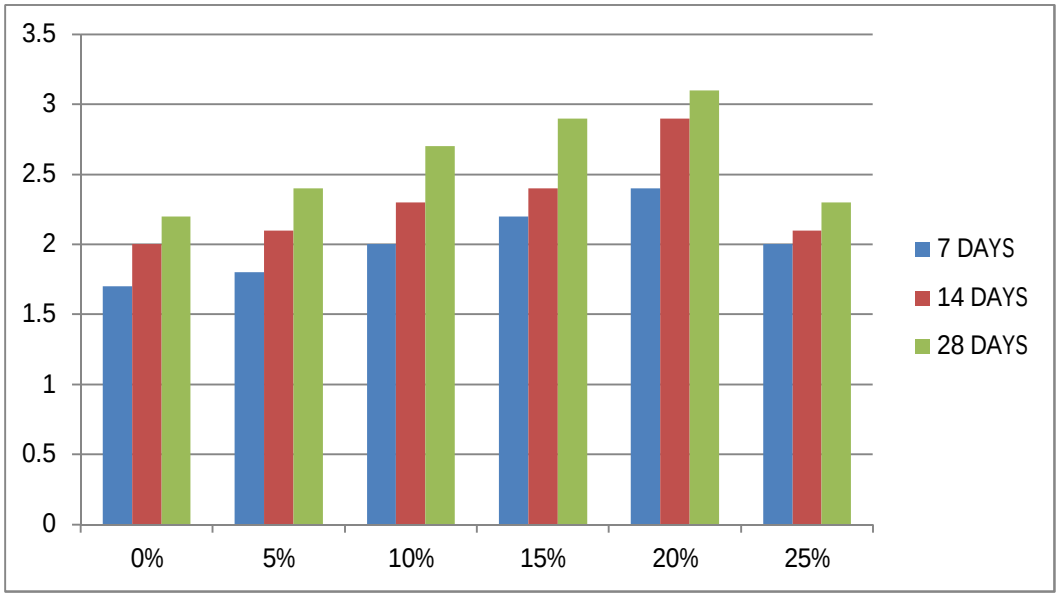
TABLE III
SPLIT TENSILE STRENGTH TEST ON CYLINDERS FOR 7,14 AND 28 DAYS

MIX %	SPLIT TENSILE STRENGTH		
	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
0	1.74	2.05	2.19
5	1.86	2.12	2.40
10	2.03	2.35	2.64
15	2.17	2.45	2.89
20	2.45	2.92	3.09
25	2.03	2.05	2.33



The above chart shows the variation in split tensile strengths for both conventional concrete and Tile powder replacing concrete cylinders with different proportions. The result shows the ultimate strength occurs in 20% of replacement of cement by Sugarcane bagasse ash.

The strength of concrete cylinder is increased by using glass fibre reinforced polymer sheet.The strength of the concrete cylinder is measured using split tensile strength test. The results show that compared to the normal concrete. Table IV shows the split tensile strength results of cylinders.

Fig.2 Wrapped specimen

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TABLE IV
SPLIT TENSILE STRNGTH VALUES

S.NO	SPLIT TENSILE STRENGTH FOR 28DAYS(N/MM2)	
	CONTROL	GFRP WRAPPED SPECIMEN
1	2.19	4.19
2	2.40	4.48
3	2.64	4.68
4	2.89	5.0
5	3.09	5.2
AVG	2.6	4.71

V. CONCLUSION

SCBA has been partly used to replace cement in concrete as it contributes beneficial properties to concrete. It improves the strength and durability of concrete. The main objective of the thesis is to study the physical and mechanical properties of concrete using SCBA at various cement replacement of 5%, 10%, 15%, 20% and 25% with water cement ratio 0.40. The results are compared with conventional concrete and cement replaced by SCBA

A. The strength of conventional concrete and SCBA replaced concrete were compared and results are analyzed.
B. From the results obtained it is clear that both the compressive strength and spilt tensile strength of SCBA replaced concrete is increased up to 20% replacement.
C. Beyond that, for 25% replacement the strength decreases.
D. In this study we conclude that SCBA can be replaced only up to 20%. Beyond the limit the strength of concrete decreases.
E. The decrease in strength is due to the reaction of chemicals present in SCBA with cement.
F. Calcium content in SCBA act as partial replacement for cement and fine aggregate.
G. The strength of the concrete cylinder is increased by using glass fiber reinforced polymer sheet
H. Hence the glass fiber reinforced polymer sheet shows better results for increasing strength.

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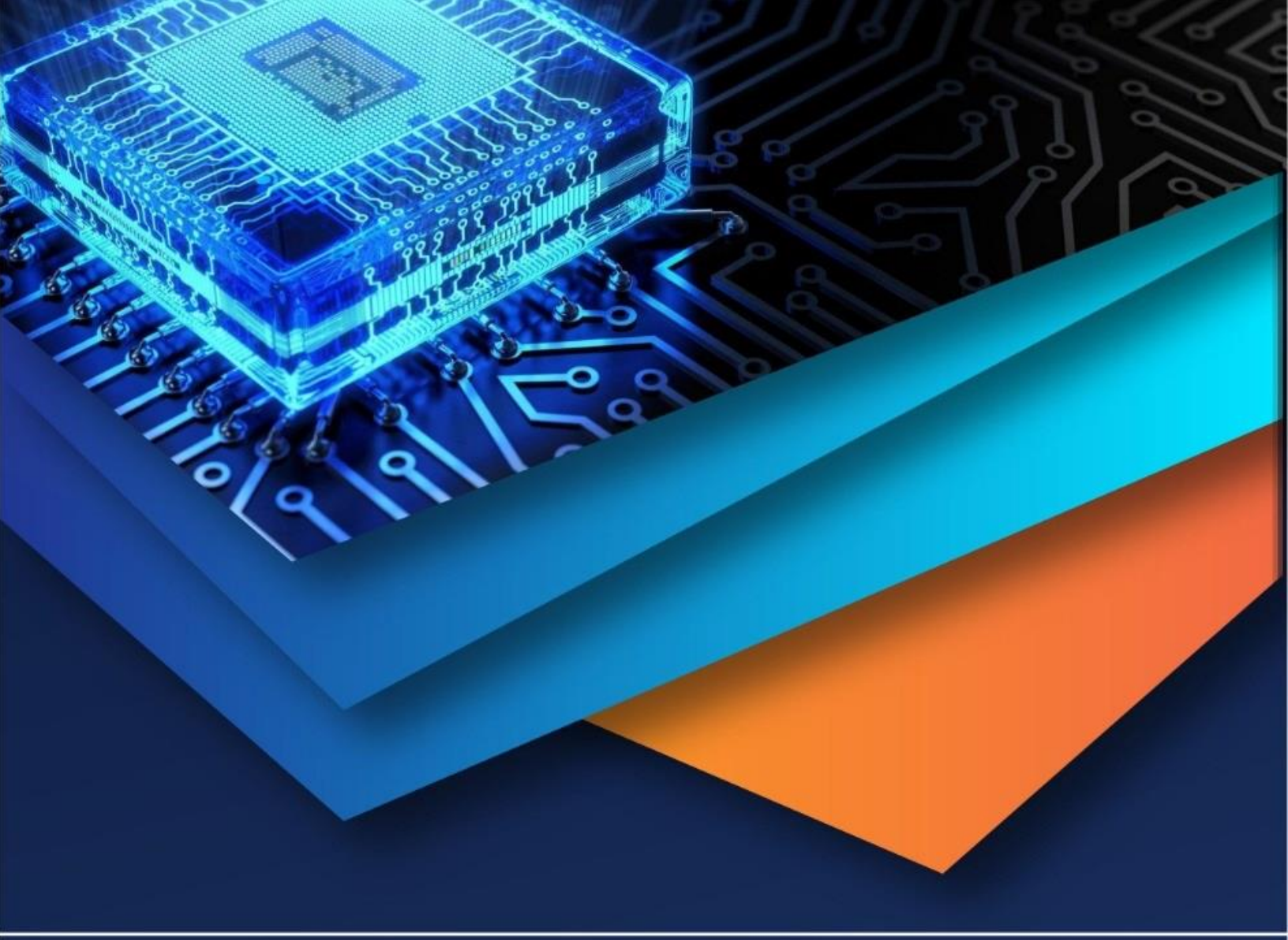

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