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Partial Replacement of Cement In Concrete By Sugarcane Bagasse Ash

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Abstract*: Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Concrete plays a vital role in the development of infrastructure in this experimental study investigation on SCBA (sugarcane bagasse ash) has carried out which is a byproduct of sugarcane and also can be used as partial replacement material with ordinary Portland cement in concrete.This imparts the earlier higher strength to the concrete .The higher amount of silica present in it reacts with the component of cement hence increase the properties of cement. The use of sugarcane bagasse ash as a partial replacement material which is the waste material from sugarcane industries helps to reduce the environmental effects cause due the emission of carbon during the manufacturing of cement. This experimental study focus on strength characteristic analysis of M20 grade concrete with replacement of cement by SCBA 10%, 20%, 30% and compare with plain cement concrete and investigate the performance of concrete mixture in terms of compressive strength of cube for 7 days, 14 days and 28 days, split tensile strength of cylinder for 28 days respectively.*

It was found that the use of SCBA up to 25% in concrete mix as replacement of cement gives more strength than the conventional concrete beyond 25% the strength of concrete get reduces.

Keywords*: Sugarcane Bagasse ash, Concrete, Compressive strength*

I- INTRODUCTION

Concrete is typically an enormous individual material element in built environment. If the concrete can be reduced without decreasing the performance or increasing the cost, significant environmental and economic benefits may be realized. Concrete mainly comprises of Portland cement, sand, aggregate and water. Sugar cane bagasse ash is a cementations material that can act as a partial replacement for Portland cement without significantly compromising the compressive strength. SCBA is a byproduct of sugar factories found after burning sugarcane bagasse.

Sugarcane is one of the major crops grown in 110 countries and its total production is over 1500 million tons. India itself produce 300 milloin tons of sugarcane per year which causes about 30% of sugarcane bagasse and 8% to 10% of bagasse ash. The amounts of silica present in bagasse reacts with component of cement and not only reduce the environmental pollution but also enhance the properties of cement.

The component of SCBA content SiO_2 66.89%, Al_2O_3 29.18%, CaO 1.92%, MgO 0.83% which can be used as an alternative source to replace cement by SCBA partially. Concrete property will be maintained with the advanced mineral admixtures such as SCBA powder as partial replacement of cement 0%, 10%, 20% and 30%. Compressive strength of SCBA concrete with different dosage of SCBA was studied as a partial replacement of cement.

Environmental sustainability is at stake both in terms of damage caused by the extraction of raw material and co_2 emission during cement manufacture. This brought pressure on the researchers for the reduction of cement consumption by partial replacement of cement by supplementary material which is naturally occurring, industrial waste or by-product that are less energy intensive.

From the structural point of view, when cement is replaced by SCBA, lower heat of hydration and higher obstructed to sulphate and chloride intrusion. Lately some attention has been given to the use of natural pozzolonas like SCBA as a partial replacement for cement. The various methods used to improve the durability of concrete, and to achieve high performance

concrete, the use of SCBA is relatively new approach. The present paper focus on the investigating characteristics of M20 grade concrete with partial replacement of cement with SCBA by replacing cement with 0%, 10%, 20% and 30%. The cubes and cylinders are tested for compressive strength and split tensile strength respectively.

1.2 Process to obtain SCBA

- Bagasse was packed in graphite crucible air tight and placed inside electric control furnace.
- Burnt at temperature of 1200℃ for 5hrs to obtain black ash.
- This carbonated bagasse was collected and burned for 6hrs at 600℃.
- After burn a layer of light colored ash was observed on the surface and then an ash of black color and heterogeneous composition was observed.
- This bagasse ash is used in the research.
- Before the use of bagasse ash, it was oven dried at 1200C.
- To remove the moisture in the ash.
- After oven dry ash was sieve in the mechanical shivers to separate unburned particles from ash.
- Sugarcane bagasse ash passing from 300µ was used.

1.3 COMPOSITION OF SCBA

Sr.No.	Component	Mass %
1	Silica (SiO2)	62.43
2	Alumina (Al2O3)	4.28
3	Ferric oxide (Fe2O3)	6.98
4	Calcium Oxide (CaO)	11.8
5	Magnesium Oxide (MgO)	2.51
6	Loss of Ignition	4.73

Sugarcane bagasse *Burnt SCBA* *After sieving SCBA*

Fig1: stages of Sugarcane Bagasse Ash

1.4 SCOPE OF THE STUDY

The increasing demand for producing durable materials is the outcome of fast polluting environment. Supplementary cementations materials prove to be effective to meet most of the requirement of the durable concrete. Sugarcane bagasse ash is found to be greater to other supplementary materials like silica fume and fly ash.when SCBA is used as partial replacement of cement in concrete reduces the problem associated with their disposals as well as decreases the emission of greenhouse gases.It also reduce the production of cement.

2. MATERIALS

2.1CEMENT

Ordinary Portland Cement of 43 Grade from single batch was used for the entire work. The cement procured was tested for physical requirements in accordance with IS: 12269-1987 and for chemical requirement in accordance with IS: 4032-1977.

Table 2.1 Physical Properties of OPC

Sr.No	Physical Properties	Test Result
1	Fineness	1.33 %
2	Standard Consistency	33%
3	Initial Setting Time	75 Min
4	Final Setting Time	480 Min
5	Soundness	3mm
6	Specific Gravity	3
7	Compressive Strength (after 28 days)	44N/mm^2

2.1 FINE AGGREGATE

The river sand, passing through 4.75 mm sieve and retained on 150 micron sieve, conforming to Zone II as per IS 383-1970 was used as fine aggregate in the present study. The aggregate was tested for its physical requirements according to IS: 2386 -1963.

Table 2.2 Physical Properties of Fine Aggregate

Sr. No	Physical Properties	Test Result
1	Specific Gravity	2.7
2	Bulk Density	9.8
3	Fineness Modulus	3.66

2.3 COURSE AGGREGATE

Throughout the investigation. Crush coarse aggregate of 20mm procured from local crushing plants was used. The aggregate was tested for its physical requirements

such as gradation, fineness modulus, specific gravity & bulk modulus etc. in accordance with IS: 2386-1963 and IS: 383-1970.

Table 2.2 Physical Properties of Course Aggregate

Sr. No	Physical Properties	Test Result
1	Specific Gravity	2.64
2	Water Absorption	0.42 %
3	Fineness Modulus	3.26

2.4 Sugarcane Bagasse Ash (SCBA):-

The sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemicelluloses of ligin. Each ton of sssugarcane 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 silica dioxide ($Sio_{2)}$. In this sugarcane bagasse ash was collected during the cleaning operation of a boiler in the sugar factory, Deccan sugar factory Pvt.Ltd. Mangrul, Yavatmal.

Table 2.4 Properties of cement with replacement of Sugarcane Baggasse ash

Replacement of sugarcane Baggasse ash	Initial	Final	Consistency	Soundness
10%	95	490	30%	3.2
20%	110	475	33%	3.3
30%	105	450	33.50%	3.5

Replacement of sugarcane Baggasse ash	Compressive strength 28 days (N/mm^2)
10%	43.5 N/mm^2
20%	45.5 n/mm^2

2.5 WATER

The water is required for preparation of mortar, mixing of cement concrete and for curing work etc. during construction work. The quality and quantity of water has much effect on the strength of mortar and cement concrete in construction work impurities free, clean portable water are used for casting of cube. Also curing was done in curing tank as per IS 456-2000.

3. MIX DESIGN

- Mix Proportion of M20

Water	Cement	Sand	Aggregate
0.55	1	1.94	2.62
197.16	297	698.13	945.45

- Quantities of Cubes

Replacement of cement by SCBA	Cement (KG)	Sand (KG)	Aggregate (KG)	SCBA (KG)	Water
0%	8.52	15.52	23.96	-	3.84
10%	7.67	15.52	23.96	0.85	4.9
20%	6.81	15.52	23.96	1.70	4.9
25%	6.02	15.52	23.96	2.13	4.9
30%	5.96	15.52	23.96	2.56	4.9

Quantity of cylinder

3. RESULTS AND DISCUSSION

3.1Results of compressive strength test for different percentages of SCBA

Sr. No	Type of Specimen	Compressive Strength N/mm^2		
		7 Days	14 Days	28 Days
1	Nominal concrete	21	22.2	21.6
2	Concrete with 10% SCBA	17.66	22.11	23
3	Concrete with 20% SCBA	18.21	22.38	23.89
4	Concrete with 25% SCBA	19.44	24.1	26.33
5	Concrete with 30% SCBA	17.22	17.88	21.51

3.2Split tensile Strength Test results for different percentages of SCBA

Sr. No.	TYPE OF SPECIMEN	SPLIT TENSILE STRENGTH IN N/mm^2(FOR 28 DAYS)
1	Nominal concrete	4.64
2	Concrete with 10% SCBA	4.82
3	Concrete with 20% SCBA	5.19
4	Concrete with 25%SCBA	6.15
5	Concrete with 30% SCBA	4.09

The above bar chart shows the variation of tensile strength with different percentages of SCBA. The 28 days tensile strength obtained is increasing up to 25% and it slightly reduced at 30%.

After 28 days, the maximum tensile strength of 6.15 was achieved for the SCBA of 25% replacement level.

IV- CONCLUSION

From Present Investigations, the following conclusions were drawn.

- SCBA in concrete gives the higher compressive strength as compare to normal strength concrete, hance optimum results were found at the 25% replacement of cement with SCBA.
- The replacement of cement with SCBA increases the workability of fresh concrete, therefore use of super-plasticizer is not essential.
- Use of high volume SCBA as a replacement of cement, in any construction work provides lower impact on environment (reduced CO emission) and economical use of resources (energy conservation, use of by-product etc.)
- Use of SCBA in the concrete generates less heat while mixing with the water as against cement. It also helps to reduce the heat of hydration resulting less shrinkage and temperature cracks in the concrete.
- The use of SCBA as a replacement of cement helps to reduce the Energy consumption in the manufacturing of cement.
- It is observed that there is an increase in the compressive strength and split tensile strength at 25 % of SCBA and after replacement of 30% it gets decreased slightly. The increase in strength is due to high reactivity of SCBA with Cement.
- From the above experimental results, it is proved that SCBA can be used as an alternative material for cement, reducing cement consumption and reducing the cost of construction. Use of industrial waste products saves the environment and conserves natural resources, achieves economy.
- Heat of hydration is slower in case of SCBA cement which lowers the risk of thermal cracking.

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