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Sustainable enhancement in Construction Sector: The Role of Sugarcane Bagasse Ash as a Partial Cement Replacement in Mortar

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Abstract: *The rate of infrastructure development increases day by day, the requirement of concrete is also increasing proportionately. The high demand for concrete or mortar is further increasing the consumption of their ingredients such as cement, sand and aggregate. Cement industry plays an important role in environmental pollution because of its CO2 emission. Therefore it becomes essential to find out the substitutes for cement. In proposed work sugarcane bagasse ash (SCBA) used as a partial replacement to cement in mortar. For obtaining better result this raw SCBA requires processing in the form of grinding. After grinding heat of hydration will be measured. Test on standard consistency, Initial&Final Setting time, compressive strength and microstructure analysis will be proposed.*

Keywords: SCBA, OPC, mortar, Compressive Strength

I. INTRODUCTION

Utilization of agricultural, industrial and agro-industrial by-products in concrete production has become an attractive area to the researchers worldwide. Utilization of such wastes as cement replacement materials also as mineral admixture can reduce the cost of concrete and also minimize the negative environmental effects associated with the disposal of these wastes.[1] Silica fume, rice husk ash, fly ash, metakaolin and ground granulated blast furnace slag are well established pozzolans because of high silica contents in their chemical composition. The calcium hydroxide (unfavorable product from the cement hydration) released during the hydration of Portland cement reacts with the silica content present in the pozzolans and water to form additional calcium silicate hydrate which is responsible for the improvement in strength in cementations mediums. Bagasse is the waste produced after juice extraction in sugar industry, which is usually used as a fuel for boilers in the sugar mills and alcohol factories which produce high amounts of ash annually. Previously the sugar cane bagasse (SCBA) was burnt as a means of solid waste disposal, with increasing of the cost of natural gas, electricity, and fuel oil and with calorific properties of these wastes, since last decade the SCBA has been used as the principal fuel in sugar factory boilers to produce heat and in cogeneration plants to produce electric power.[6]

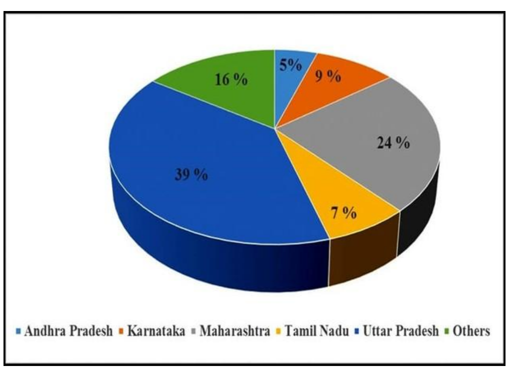

Fig. 1 Pia chart on availability of raw sugarcane bagasse ash in India

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Sugarcane Bagasse Ash (SCBA) is usually obtained under uncontrolled burning conditions in boilers, thus the ash may contain black particles due to the presence of carbon and crystalline silica when burning occurs under high temperature (above 800 ° C) or for a prolonged time. The quality of the ash can be improved by controlling parameters such as temperature, rate of heating. When the SCB is burnt under controlled conditions it may produce ash with high amorphous silica, which has the pozzolanic properties.

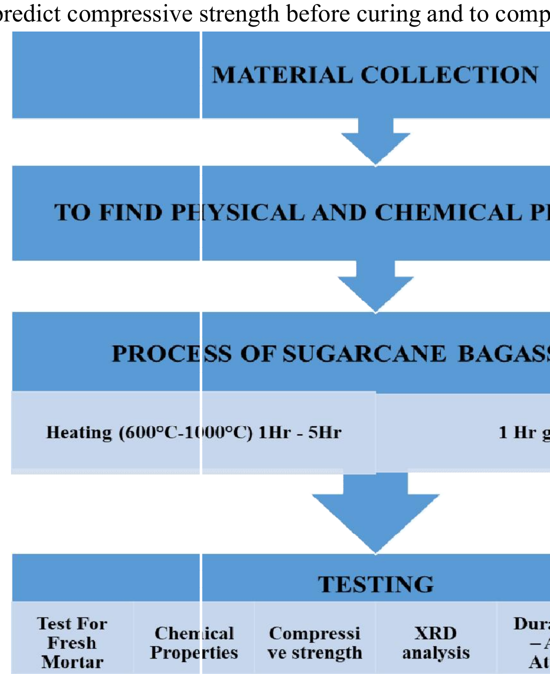
A. Problem Statement:

Nowadays, solid waste management is currently a burning issue that demands attention. Around 4.4 billon tones of solid waste generated yearly, only in Asia. However, in India, agricultural sector alone has generated about 600 million tons of residual biomass waste Around 44,000 tons of sugarcane biomass ash generated in India per day. The land application of SCBA impacts negatively on the environment, as it pollutes the soil and groundwater. Secondly the land disposal cost is also rising because of the increasing rate of biomass ash generation.

Due to the higher rate of infrastructure development, the requirement of concrete is also increasing proportionately. The high demand or demand for concentric further increasing the consumption of their ingredients such as cement, sand and aggregates cement industry plays an important role in environmental pollution because of its CO2 emissions. Therefore, it becomes essential to find out the substitutes for cement.

II. METHODOLOGY

In present study experimental investigations will be carried out on mortar with cement replaced by 0, 10, 20,&30% SCBA. One cube each will be casted for each grade and each % SCBA for workability and setting time of fresh mortar to develop relation to predict compressive strength before curing and to compare actual compressive strength.



A. Final Quantity of Cubes

• 10% OF SBA- 600-1-10

SBA-120 gm

Sand – 3600 gm Cement - 1080 gm Water- 516 ml

Casting Date – 11-8-2024

• For 20%. OF SBA-600-1-20 SBA- 240 gm

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Sand- 3600 gm Cement - 960 gm Water- 540 ml
Casting Date – 12-8-2024
- For 30% of SBA -600-1-30 SBA-360gm

Sand- 3600 gm Cement 840g Water- 564 ml
Casting Date – 12-8-2024
- 10% OF SBA- 600-2-10

Water- 547.92 ml
Casting Date – 13-8-2024
- For 20%. OF SBA-600-2-20

Water- 552 ml
Casting Date – 13-8-2024
- For 30% of SBA -600-2-30

Water- 555.96 ml
Casting Date – 13-8-2024
- 10% OF SBA- 600-3-10

Water- 564 ml
Casting Date – 21-8-2024
- For 20%. OF SBA-600-3-20

Water- 567 ml
Casting Date – 21-8-2024
- For 30% of SBA -600-3-30

Water- 576 ml
Casting Date – 21-8-2024
- 10% OF SBA- 600-4-10

Water- 552 ml
Casting Date – 22-8-2024
- For 20%. OF SBA-600-4-20

Water- 576 ml
Casting Date – 22-8-2024
- For 30% of SBA -600-4-30

Water- 583 ml
Casting Date – 22-8-2024
- 10% OF SBA- 600-5-10

Water- 559.96 ml
Casting Date – 23-8-2024
- For 20%. OF SBA-600-5-20

Water- 564 ml
Casting Date – 23-8-2024
- For 30% of SBA -600-5-30

Water- 571.92 ml
Casting Date – 23-8-2024

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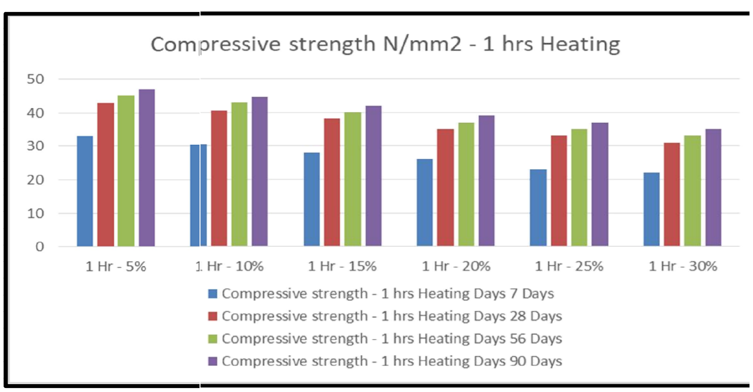
III. RESULTS OF ANALYSIS

A. Compressive strength test

Fig 2 Load application on cube

Table 1 Compressive Strength - 1 Hrs Heating

Compressive Strength - 1 Hrs Heating				
Percentage Variation By 5%	Days			
	7 Days	28 Days	56 Days	90 Days
1 Hr - 5%	33	43	45	47
1 Hr - 10%	30.5	40.5	43	44.5
1 Hr - 15%	28	38	40	42
1 Hr - 20%	26	35	37	39
1 Hr - 25%	23	33	35	37
1 Hr - 30%	22	31	33	35



Graph 1 Compressive strength N/mm2 - 1 hrs Heating Table 2 Compressive Strength - 2 Hrs Heating

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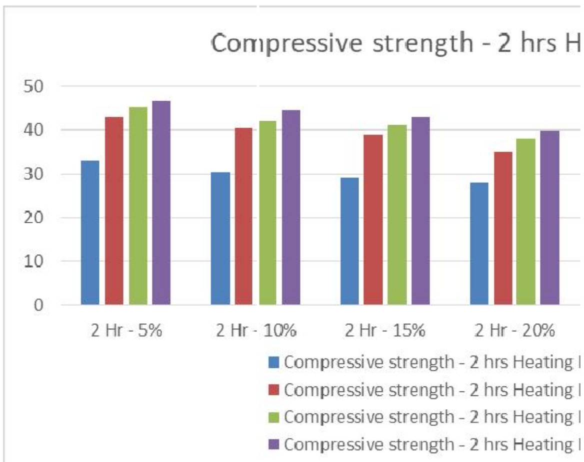
Table 2 Compressive Strength - 2 Hrs Heating

Compressive strength - 2 hrs Heating				
Percentage	Days			
Variation by 5%	7 Days	28 Days	56 Days	90 Days
2 Hr - 5%	33	43	45	46.5
2 Hr - 10%	30.5	40.5	42	44.5
2 Hr - 15%	29	39	41	43
2 Hr - 20%	28	35	38	40
2 Hr - 25%	25	33	36	38
2 Hr - 30%	22	31	33	34.5



Graph 2 Compressive strength N/mm2 - 2 hrs Heating

Table 3 Compressive Strength - 3 Hrs Heating

Compressive strength - 3 hrs Heating				
Percentage Variation by 5%	Days			
	7 Days	28 Days	56 Days	90 Days
3 Hr - 5%	33	43	45	47
3 Hr - 10%	30.5	40.5	42.5	44.5
3 Hr - 15%	28	38	40	42
3 Hr - 20%	25.5	35.5	37.5	39.5
3 Hr - 25%	23	32	34	36
3 Hr - 30%	20	30	32	34

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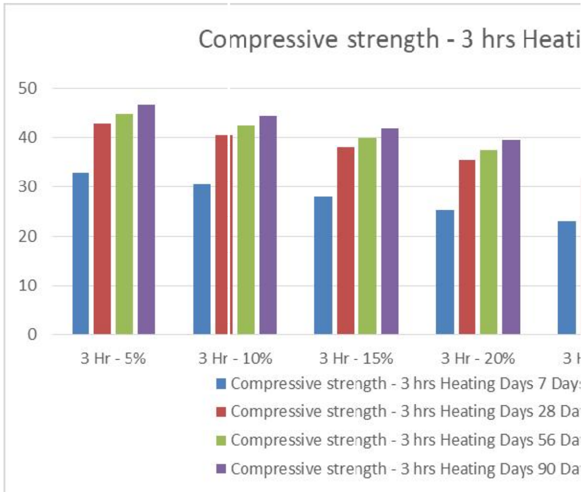
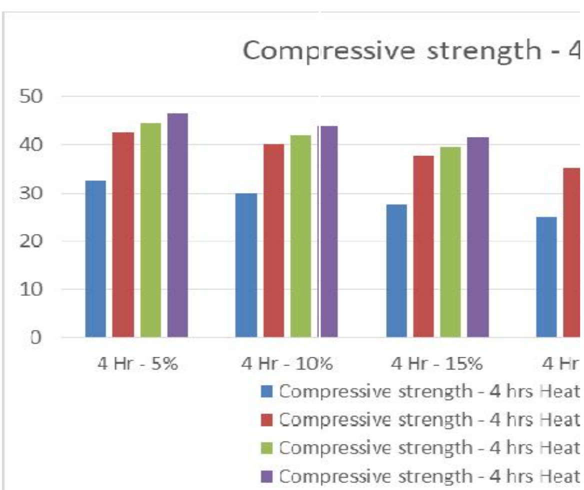


Graph 3 Compressive strength N/mm2 - 3 hrs Heating

Table 4 Compressive Strength - 4 Hrs Heating

Compressive strength - 4 hrs Heating				
Percentage	Days			
Variation by 5%	7 Days	28 Days	56 Days	90 Days
4Hr-5%	32.5	42.5	44.5	46.5
4Hr-10%	30	40	42	44
4Hr-15%	27.5	37.7	39.6	41.4
4Hr-20%	25	35	37	39
4Hr-25%	22.6	32.5	34.6	36.4
4Hr-30%	20	30.1	32.3	34



Graph 4 Compressive strength N/mm2 - 4 hrs Heating

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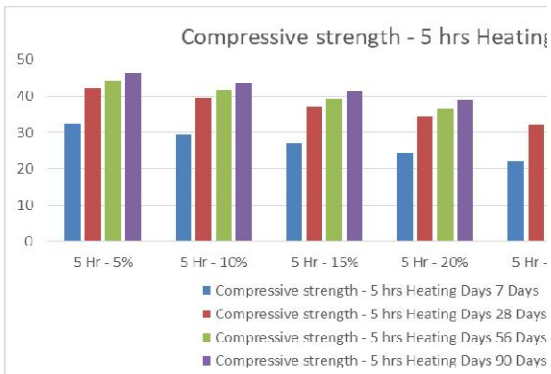
Table 5 Compressive Strength - 5 Hrs Heating

Compressive strength - 5 hrs Heating				
Percentage Variation by 5%	Days			
	7 Days	28 Days	56 Days	90 Days
5 Hr - 5%	32.2	42.1	44.2	46.2
5 Hr - 10%	29.5	39.6	41.7	43.5
5 Hr - 15%	27.1	37.2	39.1	41.3
5 Hr - 20%	24.5	34.6	36.7	38.9
5 Hr - 25%	22.2	32.1	34.2	36.1
5 Hr - 30%	20	29.9	32	33.7



Graph 5 Compressive strength N/mm2 - 5 hrs Heating

VI. CONCLUSION

This study investigated the effects of using Bagasse Ash (BA) as a partial replacement for cement in mortar mixes, focusing on performance under elevated temperature, hydration behavior, and resistance to acid attack. The experimental program evaluated compressive strength, heat of hydration, and durability properties at varying Bagasse Ash replacement levels (5% to 30%) and under different thermal conditions, particularly at 600° C for up to 5 hours.

The compressive strength tests revealed that the inclusion of Bagasse Ash influences the mechanical performance of mortar exposed to high temperatures. While strength generally decreased with prolonged heating, mixes with moderate Bagasse Ash content (particularly 10% to 20%) retained better residual strength compared to higher replacement levels. This suggests that Bagasse Ash, when used in optimal proportions, can enhance the thermal stability of cementitious materials.

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