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Investigation on Bagasse Ash as Partial Supplementary Material to Cement Mortar (MM5) and Evaluation of Compressive Strength of Brick Prism

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ABSTRACT:This study deals with assessing the possibility of using sugarcane bagasse ash (SBA) as a partial substitution of Portland cement to produce mortars. The SBA with greater pozzolanicity was characterized using chemical analysis and SEM technique. The study investigated the physical properties of materials used. To know the effect of bagasse ash on properties of cement mortar, masonry mortar grade MM5 mix is considered. The replacement of OPC with bagasse ash was made at 10%, 15% and 20% and fresh properties of mortar were obtained using flow table test, which results the flow spread would decrease with increase of SBA replacement. The test on normal mortar and the mortar with SBA was carried out. The mechanical properties such as compressive strength, flexural strength and split tensile strength were analysed experimentally for 7 and 28 days of curing. Here Mortar mix of MM5 grade with compressive strength between 4 and 7.5 MPa were achieved. The effect of sample size on the compressive strength is studied along with the replacement of cement by bagasse ash.

KEYWORDS: Mortar, SCBA, Compressive strength, flexural strength, Split tensile strength.

I. INTRODUCTION

Mortar is a man-made material that is widely used in construction. Cement, fine aggregate and water are the most common materials in mortar. Portland cement manufacturing uses a lot of raw materials from limited natural resources, releasing large amounts of carbon dioxide into the atmosphere, causing serious environmental problems. To solve these problems and reduce the impact of carbon dioxide emissions on the environment, waste can be converted into valuable materials. As an additive cement material, these waste products can be used to partially replace cement by sugarcane bagasse ash (SCBA). Improving environmental conditions by reducing cement production in the cement industry through the use of sugarcane bagasse ash (SCBA). Sugarcane bagasse ash (SCBA). must have a pozzolana character, i.e. it must have a high ratio of elements such as silica and the like. A material is classified as pozolan if its strength activity index (SAI) is at least 75%, which is determined by comparing the compressive strength development of the potential pozolanic material with the control slurry. If the mass ratio of silica + alumina + iron oxide ($SiO2$ + $Al2O3$ + $Fe2O3$) is more than 50% for class C pozolan and 70% for class F pozolan, additional chemical is required.

As supplementary cement materials, agricultural and industrial wastes such as pulverized fly ash, blast furnace slag, wheat straw ash, silica fumes, rice huskash and methacholine are now frequently used. On the other hand, bagasse ash seems to be the right choice to partially replace the cement. Because it contains silica in the respirator, it has a high pozolanic action. The activity of pozolanic to prevent silica from crystallizing is largely determined by its combustion temperature. Under these conditions, the ash produced is considered to be of high quality.

The fast growth ofsugarindustries in India leads to the production of Sugarcane bagasse ash in huge amount is increasing (67,000 tonnes/day) day by day. At present generation, the extension of volume of current plants of the

sugar factories due to the fast development of new cogeneration plants will increase the bagasse ash waste notably in the countries, which bring out more sugar. Thus, rapid increase of bagasse ash gives a disposal problem that pollutes the soils, underground water, land requirement, health Anxiety such as chemical leakage and chronic lung condition to slow plant growth; This can be overcome by using a recycling process that uses bagasse ash as an alternative cement material. India is the second largest producer of sugarcane after Brazil. The major sugarcane growing states in India are Uttar Pradesh, Karnataka, Maharashtra, Tamil Nadu, Gujarat and Andhra Pradesh. These states contribute more than 85% of the total sugarcane production in India.
The ash collection is going to happen from every state is as shown in the below chart

The cement mortar structure are weak in tension and strong in compression . Bricks are the basic masonry units used in masonry construction. Brick mortar strength is poor , the prism failure is also accompanied by failure of brick mortar bond . Attempt has made to study the performance of cement mortar with bagasse ash at various percentage . The bagasse ash mixed mortar is used for analysis of compressive strength behaviour in brickmasonry.

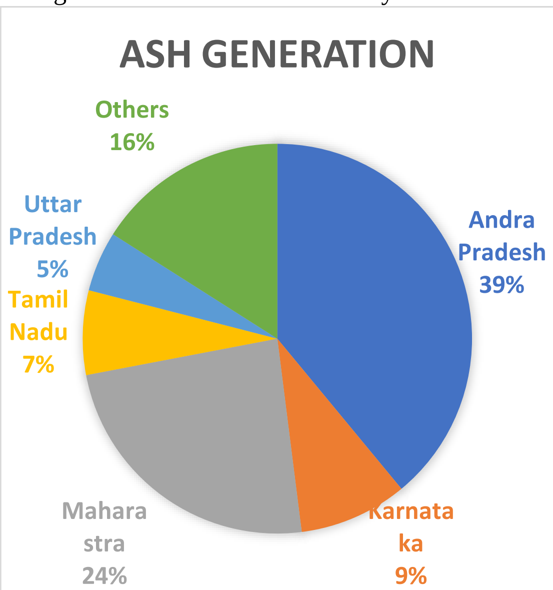

Figure 1: Ash Generation from the different part of the country.

SUGARCANE BAGASSEASH

Bagasse ash (SCBA) is produced as a by-product of bagasse combustion. This silica-rich by-product can be used as a pozzolan in cement, mortar and concrete based mortars. The use of bog ash as an additional cement component reduces methane emissions by disposing of organic waste. SCBA has the advantage of having both physical and chemical effects. The physical effects of SCBA cells are largely determined by their size, shape, and roughness. On the other hand, chemical effects (also known as pozolanic effects) are determined by the ability of cement to provide amorphous silica that reacts with Ca (OH) 2 in the presence of water during hydration. Calcium silicate hydrate is the final product of this process. The C-S-H generated by the pozolanic reaction is used as a complementary cement phase to increase the compressive strength. As a result, due to its excellent pozzolanic performance, bagasse ash can be partially replaced by cement in construction materials such as mortar, concrete floors, concrete roofing tiles and clay-interlocking cement blocks.

Figure 2:Sugar cane bagasse and Sugar cane bagasse ash

General flow diagram for sugar cane bash ash is as shown in the below figure,

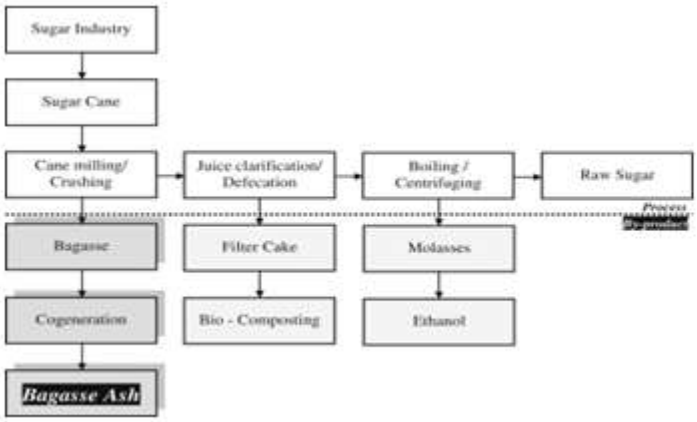

Figure 3: Flow diagram for generation of bagasse ash

II. RELATED WORK

JC Cordero, R.D. Toledo Filho, L.M. Towers (2008) [1] This paper examines the activities of Bose, Lawn and Phi Rosenmller EFF et al. The bagasse ash collected here consists mainly of silica, which can be used as mineral additives in mortar and concrete. The effect of SCBA particle size on pozzolanic activity, packing density and compressive strength of the slurry was studied. It has been confirmed that as the sensitivity of the ash increases, the compressive strength also increases. Large volume slurry of SCBA has low compressive strength. Using vibratory milling, the highest quality SCBA is produced, which provides the highest packing density of the slurry, resulting in high compressive strength and pozzolanic activity. Particle size and elegance are the main factors on which the bogus ash reaction depends.

NS Fairburn, GCCordeiro, R.D Toledo Filho (2009) [2] This work illustrates the effect of calcination temperature on bagasse ash for its pozzolanic activity. Here the bogs ash samples are fired at different temperatures under controlled calcination conditions. In this paper, the bagasse ash sample was first baked in a ventilated electric furnace at 350 ° C for 3 h to learn the pozzolanic activity at this temperature and also the bagus ash samples were fired at various temperatures ranging from 400 ° C to 800 C. . Celsius. 3 hours. Bagasse ash samples were incinerated at different temperatures using optimum pozzolanic activity, low ignition value loss and SEM and XRD analyzes to detect silica structure. After obtaining the excellent pozzolanicity of SCBA, it was classified using chemical analysis.

Nuntachai Chusilp, Chai Jaturapitakkul, Kraiwood Kiattikomol (2009) [3] This paper illustrates the effect of bagasse ash ignition value loss on compressive strength. The performance of Ground Baggage Ash with high LOI value and Ground Baggage Ash with low LOI value is described here. The raw bagasse ash collected here gives a high LOI value of 20% so it burns for 45 minutes at 550 ° C and ground, then the LOI value is reduced to 5%. The ash value that boils in the LOI may be high due to the carbon content or may not burn properly without proper pozzolanic property. In addition, a lower LOI value provides better pozzolanic material, which can be used to partially replace the cement in the slurry. To find out the compressive strength value using low (10%) and high LOI (15%) value on this basis, bogus ash is partially replaced in the slurry for a 1: 2 and 2: 1 ratio. 10% and 20%, 30% and 40% were replaced by slurry pouring. Using higher LOI values, the compressive strength of the mortar is achieved more slowly than a mortar with a lower LOI value. However, at a later age, the two types of LOI used in slurries show the same compressive strength as the bog ash. Ground bogus ash in mortar shows 10% great sulfate resistance. Furthermore, the sample of slurries made for high LOI (> 10%) baggage ashes shows a significant decrease from sulfate attack compared to the slurry made for low LOI (<10%) baggage ashes, mainly at high replacement levels (30-40%).

Sirirat Janjaturafan and Supaporn Wansom (October-December 2010) [4] In this paper four bagasse ash samples collected from a sugar factory were analyzed for their pozolanic activities using various methods. The content of amorphous SiO2 in fine and coarse bog ash was found in the range of 42-49 and 34-43% by weight using chemical analysis. A value less than 2 is recommended for the 28-day conductivity and energy activity index (SAI) method to determine the pozolanic effect of bagasse ash. Despite the low content of amorphous SiO2, the compressive strength increases when preparing cement mortar in place of 10% SCBA. It can be concluded that amorphous SiO2 content is not a major factor contributing to the increase in strength in this system. To maximize the effects of both parzolanic and filler, particle sizes can be reduced depending on their size and this will help to better understand the use of plant residues such as ash as SCM. Research has reported significant improvements in compressive strength when SCBA is used as a partial substitute in mortar.

C. Bernabe Reyes, W. Martinez Molina, E.M Alonso Guzman (2015) [5] studied the manufacture of mortar in place of cement with sugarcane ash in this paper. The increase in cement production is a major problem, leading to the emission of carbon dioxide into the air, which severely affects the greenhouse effect, and waste residues such as sugarcane ash used as an alternative to overcome this problem. Here the paste samples are made by replacing the mud ash with the embossing Remove the steel strip to check corrosion resistance. The result obtained is that corrosion increases when the steel strip is inserted into the slurry, replacing the bogus

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ash by 30%, while increasing the resistance to the bogus ash replacement by 10% and 20%.

III. METHODOLOGY

The flow of the experimental setup is as shown in the below figure,

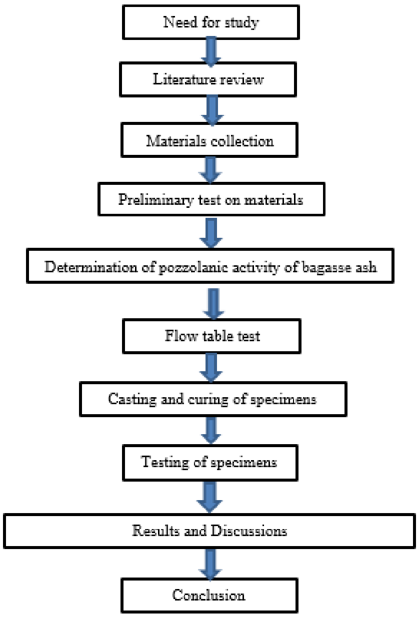

Figure 4: Experimental flow carried on.

Materials used

The materials employed for carrying out the experiment are listed below

• M Sand- Made by fine M sand used in this study. Sand does not contain clay substances, salt and organic pollutants. Artificial sand ranges from 4.75 mm to 150 m

• 53 Ordinary Portland Cement (OPC)-Common in this project is the use of Portland cement grade 53

• Sugarcane Bagasse ash (SCBA)-Sugarcane ash, residual ash collected from NSL Sugars Limited, is located in Koppa village, Maddur taluka, Mandya district in Karnataka

• Water - According to IS: 456-2009, water from the campus is used for pouring and processing. The most important part of the mortar is sand

•Mud Brick- A brick is a type of block used to build walls, pavements and other elements in masonry construction

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IS : 2250 - 1981

TABLE 1 GRADE OF MASONRY MORTARS — Contd

NOTE 1 — A, B, C, D and E denote the classes of limes to be used [see IS : 712-1973 Specification for building lime (revised)].

NOTE 2 — The strength values of lime mortars given in the table are after wet grinding of the mortar ingredients.

NOTE 3 — The compressive strength shall be determined in accordance with the procedure given in Appendix A.

*Pozzolana of minimum lime reactivity of 4 N/mm².

†This ratio by volume corresponds approximately to cement pozzolana ratio of 0·8 : 0·2 by weight. In this case, only ordinary Portland cement is to be used [see IS : 269-1976 Specification for ordinary rapid hardening and low heat Portland cement (third revision)].

The grade of the Mortor is as shown in the below figure

Tests carried on Cement while selecting

The tests carried out on the selection of cement is as shown in the below table,

Type of Test	Explanation	Apparatus setup
Specific Gravity Test	The specific gravity of cement is the division of the mass of a given volume of a sample by the mass of water equal to the same temperature	
Standard Consistency	The purpose of this test is to determine how much water should be added to the cement to make a standard paste of a general consistency.	
Initial and Final Setting Time	The time it takes to set the cement is arbitrarily divided into two parts: the initial setting and the final setting time. The time between the introduction of water into the cement and the penetration of the needle into the test block from the top of the first setting to a depth of 33–35 mm	

	is considered	
Fineness of cement	The total surface area of the cement is measured with accuracy. The fine cement surface area is large. Hydration rate, strength development, shrinkage and heat development are all affected by the softness of the cement	

TESTS ON FINE AGGREGATE

The below tests are carried out on selecting the fine aggregate.

Name of test	Details	Apparatus setup
Water Absorption and Specific Gravity of Fine Aggregate	The specific gravity of a sample is the same amount of water at the same temperature divided by the sample mass. Zero ratio, saturation level, unit weight and other sand properties are calculated using soil specific gravity. Pressure gauge is used to determine the specific gravity of sand	
Sieve Analysis	4.75 mm, 2.36 mm, 1.18 mm, 600, 300, 150 mm Basic sieves for	

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	fine overall sieve analysis	

TESTS ON BAGASSE ASH

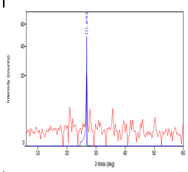
Name of loss	Calculation steps	Setup
Loss on ignition test	Loss on ignition = (W2-W3)/(W2-W1) X100	
Conductometric Method	1. Sample taken = 5 grams 2. Calcium hydroxide solution taken = 200 ml 3. Initial conductivity value = 4.35 mS 4. Final conductivity value (after 2 mins) = 3.80 mS The $\Delta\sigma 2$ min value is greater than 0.4 hence the bagasse ash exhibits variable pozzolanicity	
Bagasse ash sieving	N = (Specific gravity of Bagaase ash)/(Specific gravity of Cement) = 1.971/3.15	

TESTS ON BLENDED CEMENT

Table 1: Comparison between properties of cement and blended cement

Sl.No	Tests	Cement	Blended cement
1	Standard Consistency	32%	43%
2	Initial Setting Time	35 min	40 min
3	Final Setting Time	145 min	220 min

MICROSTRUCTURAL ANALYSIS OF BAGASSE ASH

Name of analysis	Details	Setup
Scanning Electron Microscopy	Microstructural particles in the cementitious material is the reason for knowing the activity of pozzolanic materials	
Mineralogical analysis of bagasse ash	X-ray diffraction was used to investigate minerals from sugarcane ash. The amount of amorphous and crystalline phases present in bagasse ashes is determined using X-ray diffraction studies	

Tests carried out on Mortar

Name of test	Details	Setup
Flow table test	Flow Table, Flow Mould, Caliper, Tamping rod, Trowel, Straightedge.	
FOR CONVENTIONAL MORTAR 1:4 Ratio	Top diameter of mould = 7 cm Bottom diameter of mould (do) = 10 cm Flow percentage = (Average flow dia-Dia of mould)/(Dia of mould) x100	

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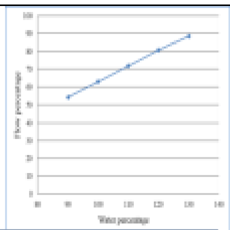
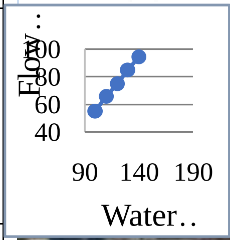
10% BAGASSE ASH REPLACEMENT OF MORTAR 1:4 Ratio	
15% Bagasse ash with Mortar	
Casting of prism	
Curing	

TEST ON HARDENED MORTAR

Test name	Details	Setup
Compressive Strength Test	Mortar compressive strength is the most common performance requirement. Cube 50x50x50mm, 70.6x70.6x70.6mm, 150xl50xl50mm cast, cylinder mold 150x300mm and curing cylinders removed from 7 day 28 day curing tank	
Split Tensile Strength Test	A 150 * 300 mm cast cylinder slurry is placed horizontally between the loading surfaces of the pressure testing machine	

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CompressiveStrength Test	220x106x75mm and curing prism removed from 7 day 14 day curing tank	

IV. RESULT AND DISCUSSION

In this section the results on the carried out experiment is provided which is as follows,

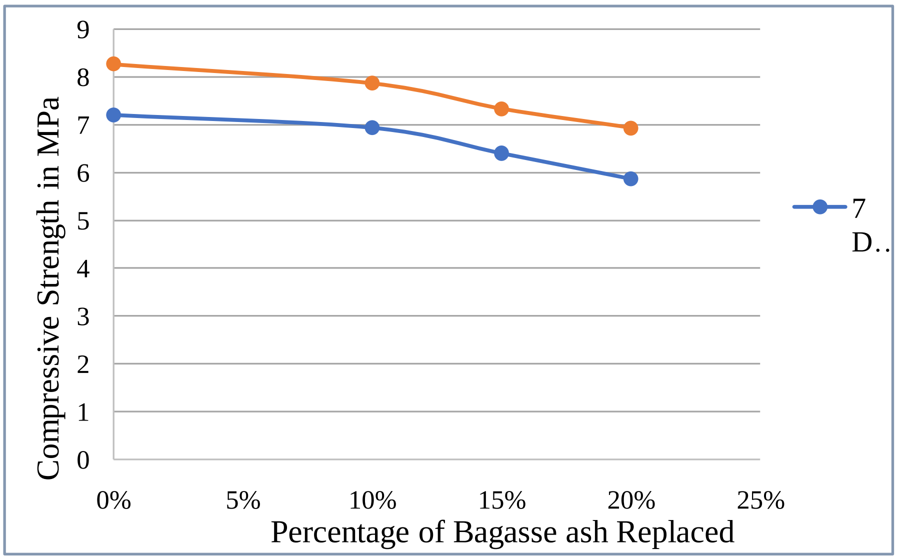
Table 2: Results of flow table test

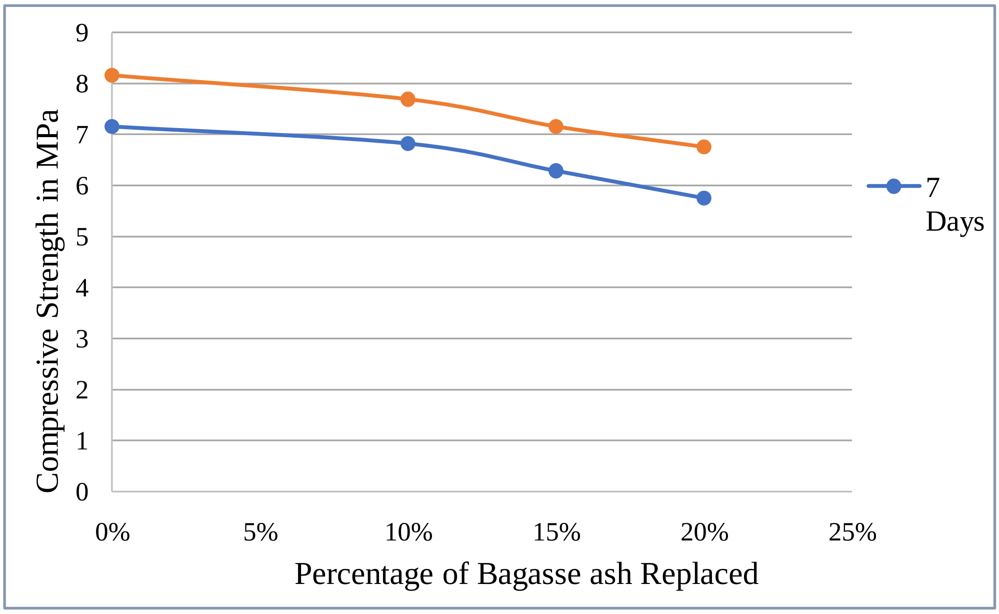
Sl.NO	% Bagasse ash replacement	Obtained water percentage
1	0%	102%
2	10%	120%
3	15%	125%
4	20%	130%

Hardened properties of mortar

Table 3: Details of tested samples

Sl.NO	Types of sample mould	Type of test	Mould size
1	cube	Compressive strength	50x50x50mm 70.6x70.6x70.6mm 150x150x150mm
2	cylinder	Compressive strength and split tensile strength	150x300mm
3	Prism mould (beam)	Flexural strength test	40x40x160mm


Compressive Strength in MPa
9
8
7
6
5
4
3
2
1
0
0%
5%
10%
15%
20%
25%
Percentage of Bagasse ash Replaced
7 D..


Compressive Strength in MPa
9
8
7
6
5
4
3
2
1
0
0%
5%
10%
15%
20%
25%
Percentage of Bagasse ash Replaced
7 Days

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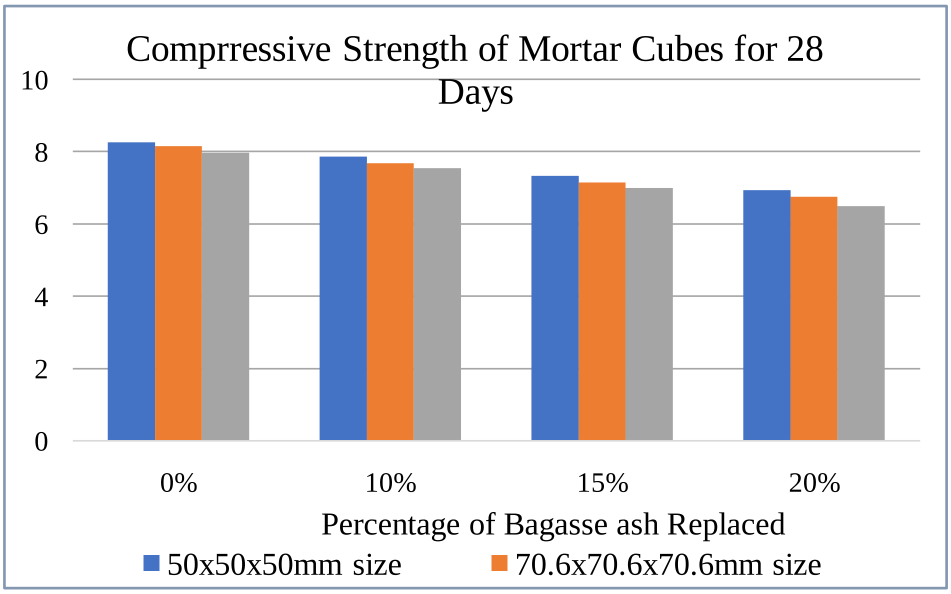

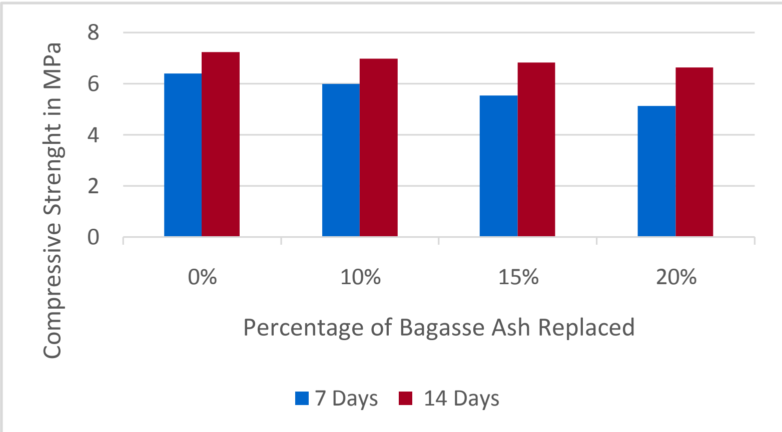

V. CONCLUSION

Based on the experimental work done, the following conclusions were drawn:

Sugarcane ash (SCBA) is a cement supplement that partially replaces cement and reduces carbon dioxide emissions into the atmosphere. Bagsse ash is an agro-industrial residue, and its disposal can lead to critical problems for the sugar industry due to environmental constraints and land requirements. At the same time, it is an access to reduce the use of natural resources and carbon dioxide production in the cement industry. Therefore, the results show the importance of replacing cement with flammable ash.

In this work, the raw bagasse ash collection showed less pozolanic activity than the minimum required for the standard (75%). Therefore, it is proposed to sift through a 150 m sieve and obtain a suitable processed bagasse ash with high pozzolanic activity.

The results obtained for testing the basic materials are within limits and satisfactory.

• Here SCBA is specialized to explore the possibility of using it in the construction field as an alternative material for cement, chemically, mineral and physically.

The cytoskeleton, prismatic shape, spherical and irregular burning phi particles of • pi brose particles were observed in the microscopic structure of ash passing through a 150 micron sieve, which was examined using SEM (electron microscopy).

Study of the mineral composition of SCBA prepared by X-ray method (XRD) used to measure the amount of amorphous and crystalline form (quartz and crystallite).

In this work, it is observed that the increase of bagasse ash replacement leads to decrease in flow spread of fresh mortar. Here properties of fresh mortar also confirm that SCBA increase the workability of mortar.
The cement replacement made at 0%, 10%, 15% and 20% by the bagasse ash and Up to 20% replacement, the minimum compressive strength required for the MM5 grade mortar mix is achieved according to IS code 2250-1981.

Here various cube sizes used for determining the compressive strength, split tensile strength and flexural strength of mortar. Also the effect of sample size on the compressive strength is studied along with the replacement of cement by bagasse ash.

By observing the obtained values, the compressive strength of 50mm cube is greater than that of 70.6mm and 150mm cube and also the cylindrical mortar (150x300mm) has a compressive strength lower than the cube strength. It can be concluded, that as the specimen size increases the compressive strength decreases.

The Split tensile strength and flexural strength of mortar specimen after 7days and 28days of curing decrease with increasing the percentage of replacement of sugarcane bagasse ash in mortar. There is no specific IS code stating the minimum flexural and tensile strength required for the mortar.

Bagasse ash is a leftover material, so using this material is economical for construction.

Carbon content is reduced as sugar cane bagasse ash is burnt at maximum temperature at 700 degree Celsius so is less harmful to out atmosphere