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Experimental Study on Partial Replacement of Sugarcane Bagasse Ash in M_{20} Concrete

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Abstract

Ordinary Portland cement is recognized at a major construction material throughout the world. All over the world today are focusing on ways of utilizing either industrial or agricultural waste, as a source of raw material for industries. This waste utilization would not only be economical, but they also result in foreign exchange earnings and environmental pollution control as industrial waste, such as blast furnace slag, fly ash and silica fume are being used as supplementary cementing material (SCMs) currently there has been on attempt to utilize the large amount of bagasse ash, the residual from sugar industry and the bagasse biomass fuel in electric generation industry. The utilization of industrial and agricultural waste produced by industrial process has been the focus of waste reduction for economically, environmental and technically reason. Sugarcane bagasse ash is fibrous waste product of the sugar refining industry along with ethanol vapor. Bagasse ash mainly contained aluminum iron and silica. The present study is aimed at utilizing sugarcane bagasse ash concrete with partial replacement of cement. The replacement is done at various percentage like 5% and 13% its effect on properties of concrete was investigate. Fresh and hardened properties were exercised with various replacement level. The study indicate that sugarcane bagasse ash can effectively be used as cement replacement (up to15%) without substantial change in strength.

Keyword – sugarcane bagasse ash, compressive strength of concrete, standard consistency of cement, TDS.

Introduction

Ordinary Portland cement is recognized as a major construction material throughout the world. Portland cement is the conventional building material that actually is responsible for about 5% to 8% global Co_2

Sugarcane is major crop grown in over 110 countries and its total production is over 1500 million tons. Sugarcane production in India is over 300 million per year in sugar-mil. We generate the waste sugarcane bagasse as homogenous material with cement concrete, its main aim to reduce the cement quantity in place of them we added sugarcane ash is 13% in 10mm aggregate of total weight of cement under the M_{20} mixed ratio.

Cement is the most widely consumable material in infrastructure development works. It is considered as durable material of construction. However, the environmental issued of cement has become a raising concern, as cement industrials are accountable around 2.5% of total worldwide waste emission from industrial source(5, 6) it is need of time to raise the use of cement replacement materials in the concrete which can reduced the significant amount cement consumption, because the production of cement required huge energy and conferring to asma (7) it is also accountable for 5% of global anthropogenic carbon dioxide release (every tone of cement produced around 01 tone of (co2), and their usage can also improve the

properties of concrete. The burning of organic waste of sugar industry known as bagasse, produced the considerable amount of ash named as sugarcane bagasse ash (SCBA). SCBA is freshly acknowledge as a pozzolanic material though, there is partial experiment statistic accessible to the effect of SCBA on behavior of concrete.

Therefore, it was highly recommended to conducting experiment of the bagasse and their impact on the concrete behavior. Generally, the bagasse waste is the disposed to the landfills or disposal site wherever present in the country and rare studies has been conveyed yet. The bagasse ash can be used as partial cement replacement in concrete. Meanwhile, in the present era there is a usage raise in the production of sugar world-wide, and almost 1500 million ton of sugar cane are yearly produced in al over the world, which leaves around 40 to 45% of bagasse afterward juice removal. So, a normal yearly production of bagasse is projected as 600 million ton, which is a bulky waste from sugar industry, (8). For the construction industry the concrete is one of the most important item which is prepared for mixing of cement, fine aggregate and coarse aggregate and within the concrete the role of cement is very vital. Without cement, 0ne cannot build reinforced structure. However, the high used of cement are an important concern of world environmental professionals. Considering the facts, one of the effective way to reduce environmental impact is to used mineral admixture, as a partial cement replacement in concrete which will have the possible to cost reduction, energy conservation, and waste emission minimization.

Therefore, releasing the significant of the issue, this experiment work is carried out to find out the optimum percentage cement replacement o0f SCBA in M20 grade of concrete, because grade M15 or M20are widely used for reinforced concrete work. Grade M40 used for very heavy reinforced concrete / pre-cast / pre-stress and M30 used for heavy reinforce concrete / pre-cast. Hence, the object of this experiment is to evaluate the performance of concrete when incorporating sugarcane bagasse ash is cement replacement in different mixed proportions.

Experimental Methodology

1. Normal compressive strength of concrete.

Compressive strength of concrete cubes test provides an idea about all the characteristics of concrete. By this single test one judge that whether concreting has been done properly or not. Concrete compressive strength for general construction varied from 15 to 30 MPa and higher in commercial and industrial structure varied from 50 to 70 MPa

General procedure of compressive strength test of concrete cubes

I. We take cement, 4.6 kg, fine aggregate 6.5kg and coarse aggregate 13.5 kg with assist of water cement ratio is 0.5 of total of cement (0.5*4.6 =2.3 liters).

II. Water has been collect from university campus where we found least value of TDS i.e. from I block, its 22ppm.

III. Mixing thoroughly with help of spade, in the mixing pan with proper mix ratio is M20 (1:1.5:3).

IV. After mixing homogeneous paste of cement concrete, we have 3 nos. of cubes, its cubes have applied grease to avoid sticking of cement concrete. Which parameter of cubes is 15 *15*15cm.

V. A cement paste has put into cubes in three layers, each layer had temping 25 nos. of blows with of

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temping rod and top surface of cube should be proper trimming.

VI. The test specimen are stored in moist air for 24 hours to proper dried and after 24 hours the specimen are marked and removed from mould and kept submerged in clear fresh water until taken out prior to test.

VII. To remove the specimen from water after specified curing time and wipe out excess water from the surface

VIII. Take the dimension of the specimen to the nearest 0.2 meter

IX. Clean and bearing surface of the testing machine.

X. Place and specimen in the machine in such a manner that the load shall be applied to opposite side of the cube cast.

XI. Align the specimen centrally on the base plate of the machine.

XII. Rotate the movable portion gently by hand so that it touches the top surface of the specimen.

XIII. Switch on the power supply after that release the pressure of CTM machine and automatically display the digital nos. which is initially starting from zero and simultaneously tight the pressure valve.

XIV. Gradually increasing load at the certain rate of KN/cm2/minute till the specimen fail and automatically display nos. goes down from maximum load

XV. Record the maximum load and note down where specimen start to break

Calculations:-

General formulae.

Compressive strength = load / area

For 7days

$P = 506*10^3 / 150*150$

$= 22.489 \text{ N/mm}^2$

For 14 days

$P = 484*10^3 / 150 * 150$

$= 21.51 \text{ N/mm}^2$

For 30 days

$P = 432*10^3 / 150*150$

$= 19.2 \text{ N/mm}^2$

Table-1

Compressive strength for different trial mix 10mm coarse aggregate.

Percentage of cement concrete	Curing period		
	7 days	14 days	28 days

Mix 1	$506x10^3$	$484x10^3$	$432x10^3$
Compressive strength N/mm2	22.489	21.51	19.2

2. Compressive strength of cement concrete with ash.

Procedure:

I. It is almost similar to above procedure, but here we added sugarcane bagasse ash to reduce of some amount cement, instead of 13% of total weight of cement.
II. Sugarcane bagasse ash has properly grinding and made into very fine particles.
III. After grinding we have sieving with help of 90 µ.
IV. All the specimen are thoroughly mixed.
V. Here we were found W/C is 0.6 weight of cement is quite higher than above normal mixed, take 4kg of cement and 0.6 kg of ash.

Calculations:-

For 7 days

$P = 310^3 / 150*150$

$= 13.8 N/mm^2$

For 14 days

$P = 275*10^3 / 150*150$

$= 12.22 N/mm^2$

For 28 days

$P = 223*10^3 / 150*150$

$= 9.91 N/mm^2$

Table-2

Compressive strength for different trial mix with Ash 10mm coarse aggregate.

Percentage replacement of bagasse ash	Curing period		
	7 days	14 days	28 days

Mix 1	310 X 10^3	275 X 10^3	223 X 10^3
Compressive strength (N/mm^2)	13.8	12.22	9.91

To determine the compressive strength of in mix 20mm coarse aggregate.

Calculations:-

For 7 days

$P = 525*10^3 / 150*150$

$= 23.33\ N/mm^2$

For 14 days

$P = 555X10^3 / 150X150$

$= 24.67N/mm^2$

For 28 days

$P = 556X10^3 /150X150$

$= 24.71N/mm^2$

Table-3

Compressive strength for different trial mix 20mm coarse aggregate.

Percentage of cement concrete	Curing period		
	7 days	14 days	28 days
Mix 1	$525*10^3$	$555*10^3$	$556*10^3$
Compressive strength (N/mm^2)	23.33	24.67	24.71

Calculations:-

For 7 days

$P= 432X10^3 / 150\ X150$

$19.2N/mm^2$

For 14 days

$P = 462\ *103\ /150\ *150$

$= 20.53N/mm2$

For 28 days

$P = 462*10^3 /150*150$

$20.53N/mm^2$

Table-4

Compressive strength for different trial mix with bagasse ash 20mm coarse aggregate

Percentage of cement concrete with bagasse ash	Curing period		
	7 days	14 days	28 days
Mix 1	$432*10^3$	$462*10^3$	$462*10^3$
Compressive strength N/mm^2	19.2	20.53	20.53

4. Mixed proportioning

In the present work, proportion for concrete mix design of M20 (1:1.5:3) were carried out according to IS: 10262-2009 recommendation. For making the mix containing sugarcane bagasse ash, the amount of powder is calculated by using the weight powder, in place of the weight of cement. The resultant mix proportion of all the mix are tabulated in table.

Fig 4.1. Cement concrete mix with bagasse ash

Table. 5

Mix proportion for M_{20} concrete with Bagasse Ash.

Parameters	Percentage replacement of Bagasse Ash		
	Control mix	Mix-1(5%)	Mix-2(13%)
W/C Ratio	0.7	0.7	0.6
Water kg/cum	3	3	2.76
Cement kg/cum	4.27	4.27	4
Fine aggregate kg/cum	6.5	6.5	6.75
Coarse aggregate kg/cum	13.5	13.5	13.5
Bagasse Ash kg/cum	0.225	0.225	0.6

Table -6

Mix proportion for M_{20} concrete with plain.

Parameters	Percentage of normal mix		
	Control mix	mix-1	mix-2
w/c ratio	0.5	0.5	0.5
Water kg/cum	2.3	2.3	2.25
Cement kg/cum	4.6	4.6	4.5
Fine aggregate kg/cum	6.5	6.5	6.525
Coarse aggregate kg/cum	13	13	13.5

5. Standard Consistency of cement.

The standard consistency of a cement paste is define as that consistency which permit the vicat plunger to penetrate to a point 5 to 7mm from the bottom and 33 to 35mm from top of the vicat mould apparatus.

Fig4.2.vicat apparatus

Calculations

Standards consistency (%) = Wt. of water added / Wt. of cement ×100

I. =105 ÷ 300 ×100 = 35%
II. = 108 ÷ 300 × 100 = 36%

Table -7

Standard consistency of cement.

Trial no	Wt. of cement (gm)	Water (cc)	Water (%)	Needle penetration (mm)
1	300	105	35	8
2	300	108	36	6

6. Standard Consistency of cement with Bagasse Ash

The cement quantity is replacement, by mineral admixture of Bagasse Ash (SCBA) and made into mortar paste.

Calculation.

Standards consistency with Bagasse Ash (%)

= Wt. of water added / Wt. of cement +Ash ×100

I. 150 ÷ (285+15) ×100 = 50%
II. 156 ÷ (285+15) × 100 = 52%

Table-8

Standard consistency of cement with bagasse ash.

Trial no.	Wt. of cement (gm.)	Wt. Ash (gm.)	Water (cc)	Water (%)	Needle penetration (mm)
1	285	15	150	50	9
2	285	15	156	52	7

7. Compressive strength of cement.

Cement is usually subjected to compressive stresses when use in form of concrete or mortar. Mortar is a mixture of cement and sand in a specified ratio on which the strength of the mortar depends. If the mortar is weak then also its compressive strength is very low but if the mortar is a strong one then its compressive strength is also very high.

The mixture sand and cement in water is generally weak in tensile and is strong in compression that is why when the concrete is subject to the tensile force then it is provided with steel rods in area of tensile i.e. it is called as a reinforce concrete.

Procedure:

- First of all, we have prepare a mixture of cement and sand having ratio of 1:3. That is one part of cement and three parts sand. We take weight of cement equal to 300gms and therefore the weight of sand equal to 555gms. This will make a 1:3mortar.
- Then we have to calculate the amount of water for this ratio according to the ASTM standards. This is 35% of total weight of cement.
- After calculation of weight make a homogeneous mixture of dry ingredient, then add water carefully to make a paste.
- Now, take the 7cm cube mould and clean them thoroughly from inside and if possible also apply some oil to the inner surfaces so that during the removal of mould the cubes are not damaged. Also fix them tight so that during compaction it is easy to compact.

- The fill one third of the mould with mortar and press it with the help of a 7/3 cm, round – ended, tempering rod. It should be tempered 25 times in each layers.
- Then fill the second one third portion of mould, and also temper it 25 time of same rod
- Adopting same procedure make two cubes mortar, one is prepared cement mortar and rest is cement mortar plus ash.
- Then we added bagasse ash 5% of total weight of cement, i.e. 15gms ash is minus from total weight of cement.
- Then keep it in open air for 1 day and after this curing 2 of them for 28 days and the keeping them in water.
- After curing of the cube take them out from the submerge water and wipe them with cloth.
- Now place the test specimen in the pressure test apparatus of UTM.
- Now carefully start the machine and start applied load automate. Applied force to the test specimen continuously and uniformly through the compressive test.
- As the load is applied on the cube it will develop crack after certain point and note down the values of breaking point
- Take out the cube and clean the compression plate surface for next test.

Calculation

Normal compressive strength of cement for 28 days

$$P = 109*10^3 / 70*70$$

$$= 22.25 N/mm^2$$

Compressive strength of cement with mix bagasse ash

$$P = 69*10^3 / 70*70$$

$$= 14.082 N/mm^2$$

Table- 9

Compressive strength of cement and mix with ash

Sl.no.	Compressive strength of cement in 28 days N/mm^2	Compressive strength of cement with ash in 28 days N/mm^2
1	109×10^3	69×10^3
Compressive strength $N./mm^2$	22.25	14.082

Results & Discussion

Compressive strength of cement concrete

The test were carried out as per IS:516-1959. The 150mm size cubes of various concrete mixture were cast to test compressive strength. The cubes specimens after de-moulding were stored in curing tanks on removal of cubes from the water the compressive strength were conducted at 7 days, 14days and 28 days and the results are represented in tabulation. The test result were compared with controlled concrete.

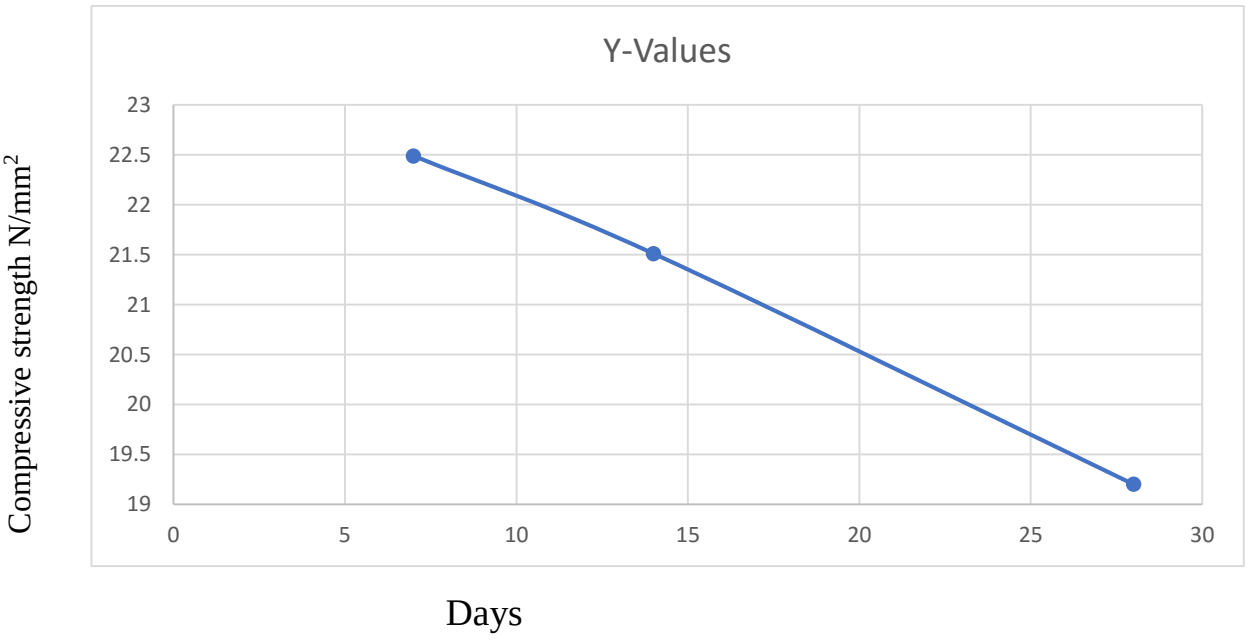
Table -10

Compressive strength for different trial mix 10mm coarse aggregate.

Percentage of cement concrete	Curing period		
	7 days	14 days	28 days
Mix 1	506 $x10^3$	484 x 10^3	432 $x10^3$
Compressive strength N/mm^2	22.489	21.51	19.2

Graph-1

Compressive strength for different trial mix 10mm coarse aggregate.



(-Values	/-Values
7	22.489
14	21.51
28	19.2

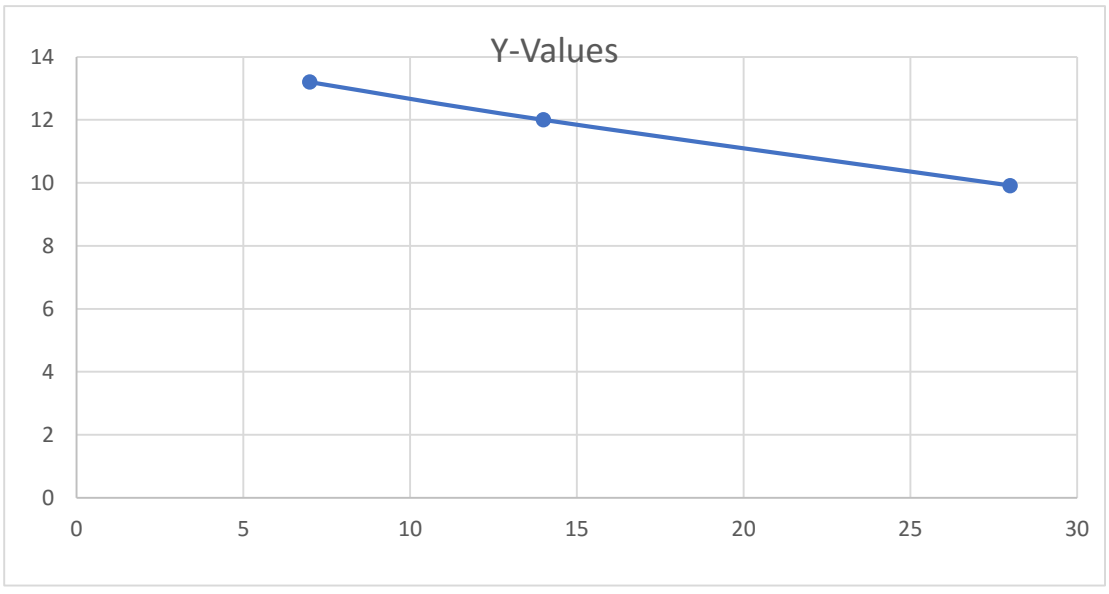
Table -11

Compressive strength for different trial mix with Ash 10mm coarse aggregate.

Percentage replacement of bagasse ash	Curing period		
	7 days	14 days	28 days
Mix 1	310 x 10^3	275x10^3	223x10^3
Compressive strength N/mm^2	13.8	12.22	9.91

Graph:-2

Compressive strength for different trial mix with Ash 10mm coarse aggregate.



(-Values	/-Values
7	13.2
14	12
28	9.91

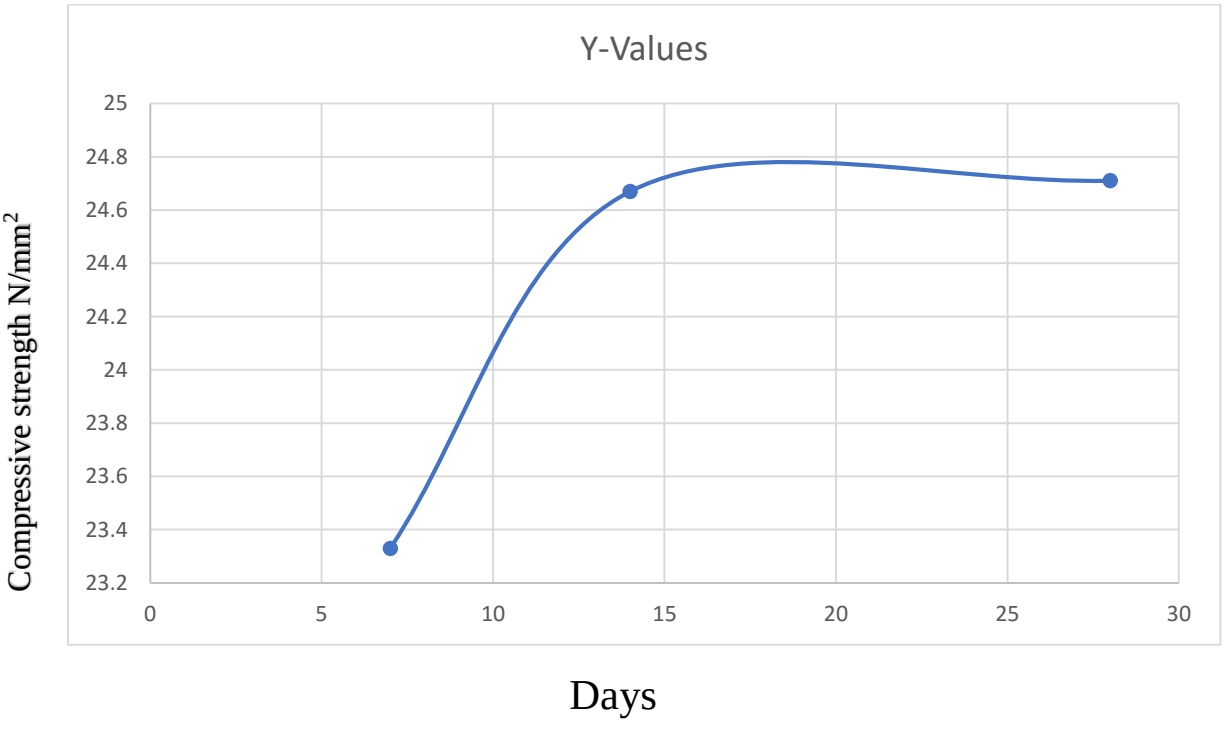
Table -13.

Compressive strength for different trial mix 20mm coarse aggregate.

Percentage of cement concrete	Curing period		
	7 days	14 days	28 days
Mix 1	525	555	556*103
Compressive strength (N/mm^2)	23.33	24.67	24.71

Graph:-3

Compressive strength for different trial mix 20mm coarse aggregate.



(-Values	/-Values
7	?3.33
l4	?4.67
?8	?4.71

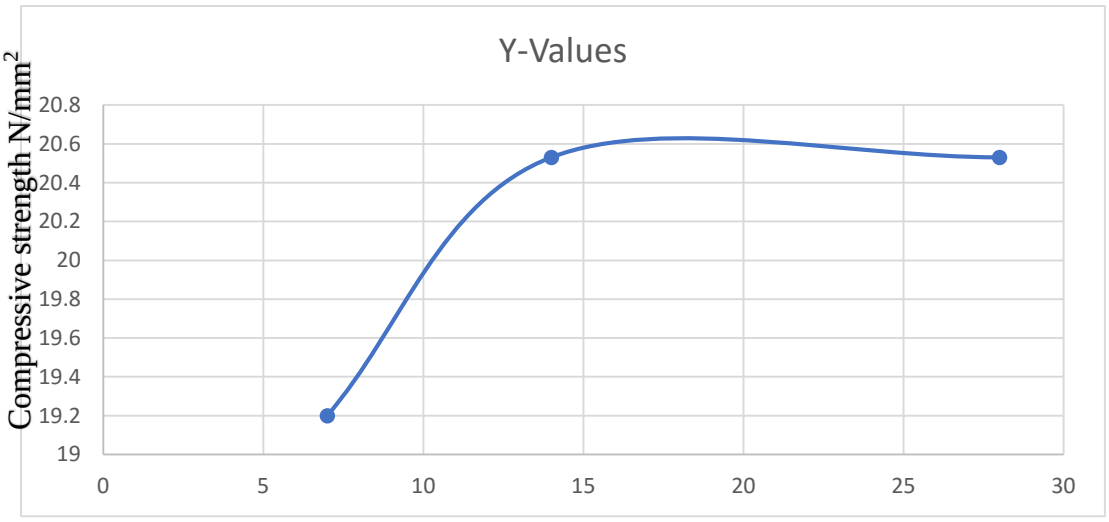
Table-14

Compressive strength for different trial mix with bagasse ash 20mm coarse aggregate.

Percentage of cement concrete with bagasse ash	Curing period		
	7 days	14 days	28 days
z Mix 1	432 x 10^3	462 x 10^3	462 x 10^3
Compressive strength N/mm^2	19.2	20.53	20.53

Graph:-4

Compressive strength for different trial mix with bagasse ash 20mm coarse aggregate.



(-Values	/-Values
7	19.2
14	20.53
28	20.53

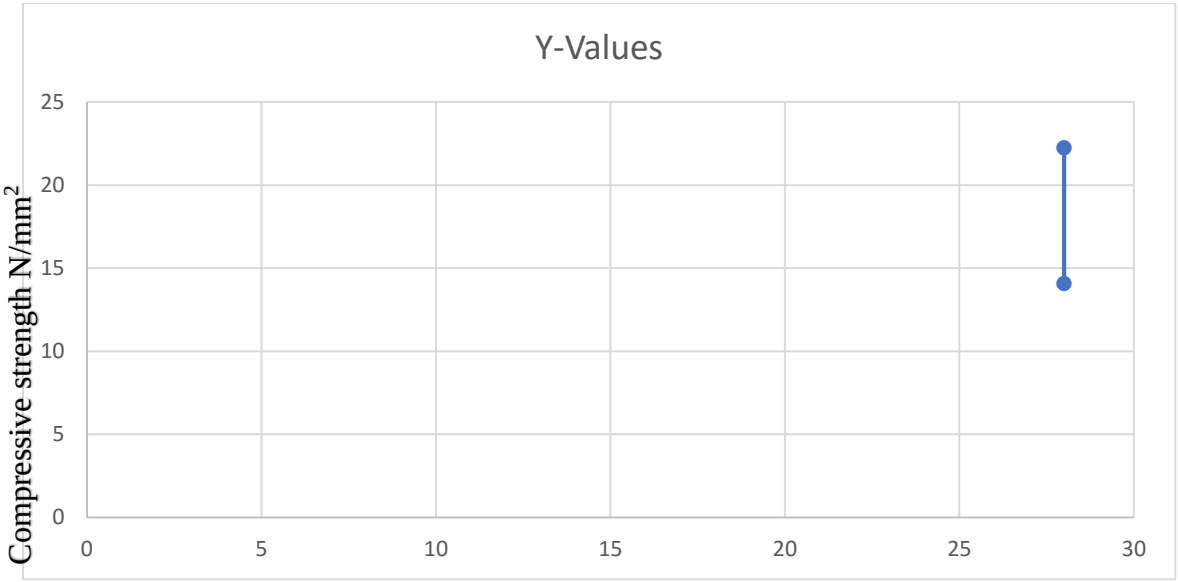
Table-15

Compressive strength of cement and mix with ash.

Sl.no.	Compressive strength of cement in 28 days N/mm^2	Compressive strength of cement with ash in 28 days N/mm^2
1	109×10^3	69×10^3
Compressive strength N./mm2	22.25	14.082

Graph:-5

Compressive strength of cement and mix with ash.



Days

(-Values	/-Values
28	?2.25
?8	l4.084

Conclusion

This experiment was successfully carried out, to the establishment of SCBA as an alternative cement replacement material in concrete. After the detail studied the following conclusion have been drawn;

- SCBA in concrete gives the higher compressive strength as compared to the normal strength concrete is 17Mpa-28Mpa for residential concrete and 70Mpa for commercial structure are specified.
- Hence optimal result were found in 10mm aggregate at the 13% replacement of cement with SCBA is 269.33Mpa in average of three cubes.
- Hence we were found in 20mm aggregate at the 5% replacement of cement with SCBA is 452Mpa in average of three cubes.
- The usage of SCBA in concrete is not only a waste-minimizing technique, also it saves the amount of cement
- The replacement of cement with SCBA increase the workability of fresh concrete, therefore, use of super-plasticizer is not essential.
- It is recommended that future engineering material to perform as ash the use of SCBA in concrete several properties for example modulus of elasticity, standard consistency of cement with bagasse ash.
- After performing 10mm aggregate, concrete with ash we found that result is simultaneously go down but 20mm aggregate , concrete with ash component is goes up.

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