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The Experimental Study of Compressive Property of M30 Concrete Using Sugarcane Bagasse Ash and Rice Husk Ash as a Partial Replacement of cement

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ABSTRACT

Husk ash as partial replacement of cement (Ordinary Portland cement 43 grade) with varying percentage of Sugarcane Bagasse ash and Rice husk ash; appear that the ratio is designed for target strength and result in increased compressive strength.

The thesis was conducted with M30 grade concrete the compressive strength test was performed on 9 number of concretes cubes of size 150 mm × 150 mm × 150 mm. The study is done with Sugarcane Bagasse Ash0%,10%, 20%, and 30% Rice husk ash 0%,10%,20% and 30% For each replacement percent of cement total 09 number ofcubes were tested 03 numbers of cube for 07 days ,03 number of cubes for 14 days and 03 numbers of cube for 28 days.

The test of compressive strength of concrete has been done and result are show in graph between the compressive strength and percentage of Sugarcane Bagasse Ash and Rice husk ash.

This research has shown that the Sugarcane Bagasse Ash and Rice husk ash. Have potential to produce high performance of concrete and it will also improve the properties fresh and hardened concrete.

KEY WORDS: - Rice husk ash (RHA), Sugarcane Bagasse Ash (SBA), cement replacement, concrete, Compressive strength, Workability

1. INTRODUCTION

There has been alarming rate of increase in the price of building materials in the recent past. This has necessitated government, private and individuals to go in research for locally sourced materials to supplement (replace-fully or partially) the conventional materials. The increasing demand for cement and concrete is met by the partial replacement of cement. The whole concept of this idea is to ensure that an average working-class citizen of India will be able to own a house. Concrete is a composite material which consists eccentrically of a binding medium. Concrete is no longer made of aggregate Portland cement and water only. Often but not always it has to incorporate at least one of the additional ingredients such as admixture or cementations material to enhance its strength and durability. Within which are embedded particles or fragments of relative inert filler in Portland cement concrete. The binder is a mixture of Portland cement. The filler may be any of a wide variety of natural or artificial. Fine and coarse aggregate; and in some instances, an admixture. Concrete is presently one of the most popular materials used in building construction and other civil engineering works. When reinforced with steel, it has a higher capacity for carrying loads. Concrete being a heterogeneous material. The quality of the constituents and the proportions in which they are mixed, determine its strength and other properties.

RH

RHA

SCB

SCBA

2. LITERATURE REVIEW:

Ankit Kumar, 2016 have worked on the partial replacement of cement in the proportion of 0% ,20% and its effect on workability of concrete made with rice husk ash and investigated for the 20% rice husk ash replacement, the hardened properties such as compressive strength observed were good as compare to 0 % RHA. The compressive strength test was conducted at 0 % and 20 % rice husk ash replacement and the highest compressive strength at 20 % RHA replacement as compared to 0% RHA replacement at 14 ,21 and 28 days.

, 2015aimed at putting into effective use Rice Prashant D. Hiwase **and** Mukesh Shewakram BalwaniHush Ash a local additive which has been investigated to be super pozzolanic in a good proportion to reduce the high cost of structural concrete. Cement mortar paste were proportioned with varying dosages of RHA as partial replacement of OPC in the range of 0% to 15% with the gradual increase of RHA by 2.5%. It is found that the compressive strength of hardened concrete is decreasing with percentage increase in RHA.

G. Siva Kumar et al had studied on "Preparation of Bio-cement using Sugarcane bagasse ash and its Hydration behavior". In this study they had used as partial Replacement in ordinary Portland Cement (OPC) by 10% weight. Compressive strength of the sample was carried out and reported that the Cementous material in sugar cane bagasse ash is responsible for early hydration. The pozzolanic activity of bagasse ash results in formation of more amount of C-S-H gel which results in enhances the strength, and hence bagasse ash is a potential replacement material for cement.

H.S. Otuoze et al, had investigated on "Characterization of Sugar Cane Bagasse ash and ordinary Portland Cement blends in Concrete", The SCBA is obtained by burning Sugar cane Bagasse at between 600-700 degrees Celsius, since the sum of Sio2, Al2o3 and Fe2o3 is 74.44%, For strength test, mix ratio of 1:2:4 was used and OPC was partially replaced with 0% ,5%, 10%, 15%, 20%, 25%, 30%, 35%, 40% by weight in concrete. Compressive strength values of hardened concrete were obtained at the ages of 7,14,21,28 days. Based on the test conducted, it can be concluded that SCBA is a good pozzolana for concrete cementation and partial blends of it with OPC could give good strength development and other engineering properties in concrete. An optimum of 10% SCBA blends with OPC could be used for reinforced concrete with dense aggregate. Higher blends of 15% and up to 35% of SCBA with OPC are acceptable for plane or mass concrete. The value fell short of meeting requirements for reinforced concrete with dense aggregate because of excessive fines from increasing SCBA and reducing Strength of bonding.

3.METHODOLOGY AND EXPERIMENTAL PROCEDURE:

The aim of this experimental investigation is to study the variation in strength characteristics of concrete structural elements, for the proportion of M30 grade. In each mixes containing different percentages of Rice husk ash (RHA) and sugarcane bagasse Ash (SBA) is replaced by means of cement starting from 0% as normal concrete, i.e., controlled concrete10%, 20%, and 30%, The number of specimens casted for each case is as follows.

1.Workability of concrete test like slump cone test and compaction factor test.

2.Mechanical properties like Compressive strength,

3.1 EXPERIMENTAL VIEW

Table:1 Casting and Curing of M30 Grade of Concrete with 0% Rice husk ash and 0% sugarcane bagasse Ash.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in days	Remark
1	Cube	M30	M1	9 no's	7, 14,28	Cube size 150x150x 150mm

Table:2 Casting and Curing of M30 Grade of Concrete with 10% Rice husk ash and 0% sugarcane bagasse Ash.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M30	M2	9 no's	7, 14,28	Cube size 150x150x 150mm

Table:3 Casting and Curing of M30 Grade of Concrete with 20% Rice husk ash and 0% sugarcane bagasse Ash.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M30	M3	9 no's	7, 14,28	Cube size 150x150x 150mm

Table:4 Casting and Curing of M30 Grade of Concrete with 30% Rice husk ash and 0% sugarcane bagasse Ash.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
	Cube	M30	M4	9 no's	7, 14,28	Cube size 150x150x 150mm

Table:5 Casting and Curing of M30 Grade of Concrete with 0% Rice husk ash and 10% sugarcane bagasse Ash.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M30	M5	9 no's	7, 14,28	Cube size 150x150x 150mm

Table:6 Casting and Curing of M30 Grade of Concrete with 0% Rice husk ash and 20% sugarcane bagasse Ash.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M30	M6	9 no's	7, 14,28	Cube size 150x150x 150mm

Table:7 Casting and Curing of M30 Grade of Concrete with 0% Rice husk ash and 30% sugarcane bagasse Ash.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M30	M7	9 no's	7, 14,28	Cube size 150x150x 150mm

Table:8 Casting and Curing of M30 Grade of Concrete with 5% Rice husk ash and 5% sugarcane bagasse Ash.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M30	M8	9 no's	7, 14,28	Cube size 150x150x 150mm

Table:9 Casting and Curing of M30 Grade of Concrete with 10% Rice husk ash and 10% sugarcane bagasse Ash.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M30	M9	9 no's	7, 14,28	Cube size 150x150x 150mm

Table:10 Casting and Curing of M30 Grade of Concrete with 15% Rice husk ash and 15% sugarcane bagasse Ash.

Sl. No.	Particular	Mix Design	Code	No. of Specimen	Curing period in Days	Remark
1	Cube	M30	M10	9 no's	7, 14,28	Cube size 150x150x 150mm

Table No. 13: Sieve analysis of fine aggregate

SR. NO	IS SIEVE SIZE	Weight retained (gm)	Correction	Corrected weight	Cumulative weight retained	Cumulative percentage weight retained	Cumulative percentage passing
1	10mm	-	-	-	-	-	-
2	4.75mm	25	+0.5	25.5	25.5	2.55	97.45
3	2.36mm	29	+0.58	29.58	55.08	5.508	94.50
4	1.18mm	209	+4.18	213.18	268.26	26.826	73.18
5	600µ	317	+6.34	323.34	591.60	59.16	40.84
6	300µ	350	+7.0	357	948.60	94.86	5.16
7	150µ	50	+1.0	51.0	999.6	99.96	0.04

3.3Properties of Fine Aggregate:

Fineness modulus of fine aggregate = cumulative percentage weight retained/100

Fineness modulus = 288.864/100

= 2.88

Specific gravity = 2.68

Water absorption =0.86%

Silt or clay content = 0.5%

Bulk density = 1520kg/m³

Grading =well graded (zone II).

3.4 Coarse Aggregate:

The coarse aggregate used in this investigation in 20mm downsize crushed aggregate and angular in shape as per Indian Standard specifications IS: 383 – 1970 [16]. Its physical properties and sieve analysis results are shown in table as follows

Table 12: Sieve analysis of coarse aggregate

Sr. No	Is sieve size	Weight retained (gm)	Cumulative weight retained	Cumulative percentage weight retained	Cumulative percentage passing.
1	63.00	0.00	0.00	0.00	100
2	40.00	0.00	0.00	0.00	100
3	20.00	2000	2000	20.00	80.00
	12.50	7580	9580	95.80	4.20
5	10.00	220.0	9800	98.00	2.00
6	8.00	120.0	9920	99.20	0.80
	6.30	40.00	9960	99.60	0.40
8	4.75	20.00	9980	99.80	0.20
9	Pan	20.00	10,000	-	0.00

Properties of Coarse Aggregate:

Fineness modulus of coarse aggregates = cumulative percentage weight retained/100

Fineness Modulus =512.40/100

= 5.12

Specific gravity = 2.7

Water absorption = 1.12%

Impact value = 11.76%

Bulk density = 1440kg/m³.

3.5 Water [IS: 456-2000]:

Water used for both mixing and curing should be free from injurious number of deleterious materials such as acids, alkalis, salts, organic materials etc. Potable water is generally considered satisfactory for mixing and curing concrete. In present work potable tap water was used.

3.6 Fresh Concrete Properties:

Fresh concrete properties such as slump, unit weight, temperature and Air-content, compaction factor were determined according to Indian Standard Specification IS: 1199-1959.

3.7 Slump Cone Test:

This is a test used extensively in site work all over the work. The slump test does not measure the workability of **concrete** although ACI 116R – 90 describes it as a measure of consistency, but the test is very useful in detecting variations in the uniformity of a mix of given nominal proportions. The slump test is prescribed by IS: 456 (2000), ASTM C 143 90A and BS 1881 Part 102:1983. The mold for the slump test is a frustum of a cone, 300mm (12inch) high. It is placed on a smooth surface with the smaller opening at the top and filled with concrete in three layers. Each layer is tamped 25 times with a standard 16mm (5inch) diameter steel rod, rounded at the end, and the top surface struck off by means of a sawing and rolling its base during the entire operation, this is facilitated by handles or foot rests brazed to the Mould. Immediately after filling, the cone is slowly lifted, and the unsupported concrete will now slump hence the name of the test. The decrease in the height of the slumped concrete is called slump and is measured to the nearest 5mm (1/4 inch). The decrease is measured to the highest point according to IS: 456-2000 b5 1881: Part 102: 1983, but to the displaced original center according to ASTMC 143-90a. In order to reduce the influence on slump of the variation in the surface friction, the inside of the mould and its base should be moistened at the beginning of every test, and prior to lifting of the Mould the area immediately around the base of the cone should be cleaned of concrete which may have dropped accidentally.

Instead of slumping evenly all rounds as in true slum figure one of the cones slides down an inclined plane, a shear slump is said to have taken place, and the test should be repeated.

If shear slump persists, as may be the case with harsh mixes, this is an indication of lack of cohesion in the mix

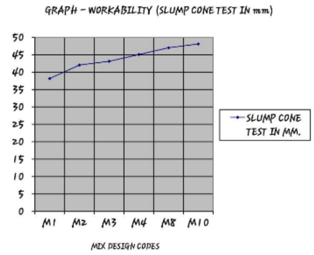
Table:13 Description of workability and magnitude of slump

Description of workability	Slump in mm
No slump	0
Very low	5 – 10
Low	15 – 30
Medium	35 – 75
High	80 – 155
Very high	160 to collapse

Source: IS code 10262(2009)

Table: 14 Workability of various concrete mixes design for slump cone test is as follows

Mix design codes	Slump cone test in mm.
M1-MIX (normal concrete)	38
M2-MIX (10% RHA)	42
M3-MIX (20% RHA)	43
M4-MIX (30% RHA)	45
M8-MIX (5% SCA AND 5% RHA)	47
M10-MIX (15% SCA AND 15% RHA)	48



Graph No: 1: Workability (Slump Cone Test in mm)

3.8 Compaction Factor test:

The degree of compaction, called the compaction factor, is measured by the density ratio i.e., the ratio of the density actually achieved in the test to the density of the same concrete fully compacted. The test, known as the compacting factor test, is described in BS 1881: Part 103: 1993 and in ACI 211.3-75 (Revised 1987) (reproved 1992), and appropriate for concrete with a maximum size of aggregate up to 40mm. The apparatus consists essentially of two hoppers, 2 each in the shape of a frustum of cone, and one cylinder, the three being above one another. The hoppers have hinged doors at the bottom, as shown in figure. All inside surfaces are polished to reduce friction.

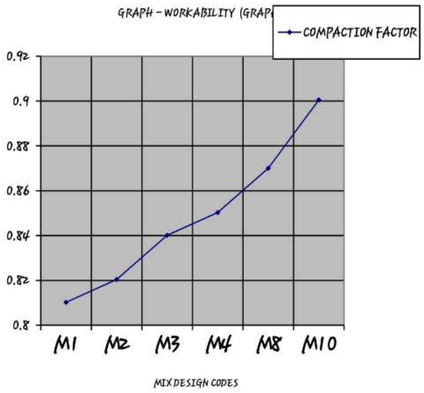
The upper hopper is filled with concrete, this being placed gently so that at this stage no work is done on the concrete to produce compaction. The bottom door of the hopper is then released and the concrete falls into the lower hopper. This is smaller than the upper one and is, therefore, filled to overflowing, and thus always contains approximately the same amount of concrete in a standard state; this reduces the influence of the personal factor in filling the top hopper. The bottom door of the lower hopper is then released and the concrete falls into the cylinder. Excess concrete is cut by two floats slid across the top of the mould.

The density of the concrete in cylinder is now calculated, and this density divided by the density of the fully compacted concrete is defined as the compacting factor. The letter density can be obtained by actually filling the cylinder with concrete in four layers; each tamped or vibrated, or alternatively calculated from the absolute volumes of the mix ingredients. The compacting factor can also be calculated from the reduction in volume that occurs when a defined volume of partially compacted concrete (by passing through the hoppers) to fully compacted.

The compacting factor = weight of partially compacted
Concrete/Weight of fully compacted concrete.

Table:15Workability of various concrete mix design for compaction factor test

Serial No.	Mix Design Code	Compaction Factor
1	M1	0.81
2	M2	0.82
3	M3	0.84
4	M4	0.85
5	M8	0.87
6	M10	0.90



Graph2: Workability (Graph Compaction Factor)

3.9 Details of Specimens Used:
150mm x 150mm x 150mm cube specimens for Compressive strength.

Figure: Mixing of materials and casting

Figure: Freshly Placed Specimen

Figure :Cubes, ready for curing
No. 2: Workability (Graph Compaction Factor

Figure: Curing of Specimens

4.0 Test for Compressive Strength of Concrete (IS: 516-1959):

The compressive strength of concrete is one of the most important Properties of concrete in most structural application concrete is implied primarily to resist compressive stress.

In the investigation, conventional concrete Rice husk ash (RHA), Sugarcane Bagasse Ash (SBA), composite, concrete cubes of 150mm x 150mm x 150mm sizes were used for testing the compressive strength. The cubes are tested in a compression-testing machine of capacity 2000kn. The load has been applied at a rate of 315kn/mm. The load applied in such a way that the two opposite sides of the cubes are compressed. The load at which the control specimen ultimately fail is noted. The average of three cubes is taken as compressive strength. Compressive strength is calculated by dividing load by area of Specimen.

Fc = p/a.

Were,

fc = cube compressive strength in N/mm²

P = cube compressive causing failure in N.

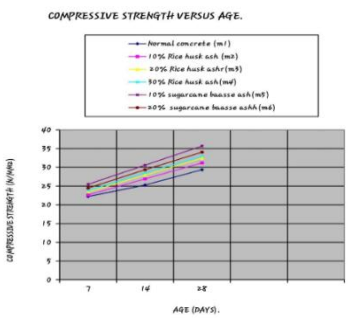
A = cross-sectional area of cube

Numbers of cubes tested for different proportions with conventional concrete and at different percentage of Rice husk ash(RHA), Sugarcane Bagasse Ash (SBA)concrete as shown in table and graph.

Figure: Set Up for Compressive Strength

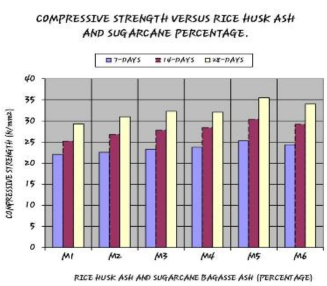
Table 16: Compressive Strength of Grade M30 as M1, M2, M3, M4, M5, M6,M7,M8, M9,M10

Mix	**M-1**	**M-2**	**M-3**	**M-4**	**M-5**	**M-6**	**M-7**	**M-8**	**M-9**	**M-10**
RHA%	0	10	20	30	00	00	0	5	10	15
(SBA) (%)	0	0	0	0	10	20	30	5	10	15
Test age (days)	**3-3 SAMPLES COMPRESSIVE STRENGTH (N/mm²)**									
7	22.0 22.5 22.0 Av=22.1	22.6 22.5 22.6 Av=22.5	23.3 23.2 23.4Av=23.3	23.7 23.8 23.9 Av=23.8	25.3 25.5 25.1 AV=25.3	24.8 24 24.4 AV=24.4	24.0 23.1 25.2 Av=24.1	27.9 28.0 27.8 Av=27.9	24.9 26.5 26.3 Av=25.9	24.5 24.4 25.2 Av=24.7
14	25.0 25.0 25.6 Av=25.2	26.7 26.8 26.9 Av=26.8	27.7 27.8 27.9 Av=27.8	28.4 28.3 28.5 Av=28.4	29.0 31.8 30.4 Av=30.4	29.2 305 28.5 Av=29.2	29.6 28.0 28.8 Av=28.8	32.8 32.9 32.7 Av=32.8	32.2 31.0 30.4 Av=31.2	29.5 30.7 28.6 Av=29.6
28	29.5 29.0 29.5 Av=29.3	30.0 31.0 32.0 Av=31	32.2 32.3 32.4Av=32.3	32 31.5 33 Av=32.1	36.5 34.5 35.5 Av=35.5	35.0 33.0 34.0 Av=34	34.5 32.5 33.5 Av=33.5	37.0 36.5 36.0 Av=36.5	37.0 38.0 37.5 Av=37.5	34.5 33.5 35.5 Av=34.5

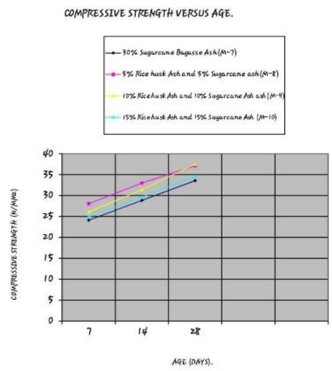


Graph 3: Showing the variation of compressive strength with age for various Rice huakAsh and Sugarcane bagasse Ash percentages of M30 grade

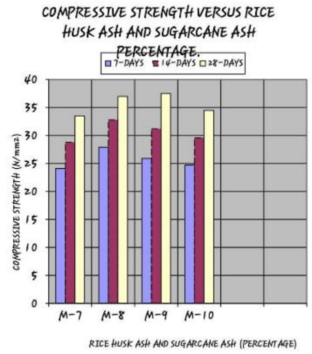
grade



Graph 4: Showing the variation of compressive strength with age for various Rice huakAsh and Sugarcane bagasse Ash percentages of M30 grade



Graph 5: Showing the variation of compressive strength with age for various Rice huakAsh and Sugarcane bagasse Ash percentages of M30 grade.



Graph 6:Showing the variation of compressive strength with age for various Rice huak Ash and Sugarcane bagasse Ash percentages of M30 grade

4.RESULTS & DISCUSSION:

1.Compressive strength of concrete mixes made with and without rice husk ash and sugarcane bagasse ash with different percentage were determined at 7, 14, and 28 days of curing. The test results are given in table and shown in figure. The maximum compressive strength was obtained for a mix having a 10% rice husk ash of 10% sugarcane bagasse ash by weight and increase in strength over plain concrete.

2.The 7-day compressive strength of rice husk ash and sugarcane bagasse ash concrete was found to be high as 27.9 Mpa. Which is more than ordinary concrete. Similarly, 28-day compressive strength was found to be about 37.5 Mpa which is more than that of ordinary concrete.

3.The effect of replacement of cement with three percentages of Rice husk ash and sugarcane bagasse ash on the compressive strength of concrete is shown figure. It is clear that the replacement of cement with 30 % of Rice husk ash and sugarcane bagasse ash reduced the compressive strength of concrete. And for a particular percentage of Rice husk ash and sugarcane bagasse ash there was a decrease in compressive strength of concrete, as the percentage of rice husk ash and sugarcane bagasse ash from 10% to 20%. However, this reduction in strength with addition of Rice husk ash and sugarcane bagasse ash continued to decrease with an increase in the percentage of Rice husk ash and sugarcane bagasse ash content. Generally, presence of Rice husk ash and sugarcane bagasse ash induces porosity and reduces compressive strength depending upon Rice husk ash and sugarcane bagasse ash content.

5.CONCLUSION

The result of study shows that there are good prospects of using Rice husk Ash (RHA), Sugarcane Bagasse Ash (SBA) as a pozzolana combination with ordinary Portland cement (OPC) in the Concrete cube. M-30 grade concrete cube is casted and its compressive strength and workability is determined. The combination of 10%, 20% and 30% cement replacement Mix is prepared by using agricultural waste.

Workability of the concrete increased with the increased percentage of Sugarcane Bagasse Ash in concrete and decreased with increased percentage of Rice husk. It has been observed that Sugarcane Bagasse gives very good workability when they replace cement in concrete.

Compressive Strength of concrete increased with increasing percentage mix give good compressive strength. When Rice Husk Ash replace cement in concrete it has been observed that its 10% and 20% mix gives good compressive strength.

Concrete is a versatile building material which is largely used in construction. When cement is replaced by this waste material up to 30%. By using these waste material INR 94.5/- can be saved on per bag of cement i.e., 30% of the cost.

From the study conducted, it was clearly shown that Rice husk ash (RHA), Sugarcane Bagasse Ash (SBA), are pozzolanic material and can contribute to the sustainability to the construction material.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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