Experimental Investigation of Strength Parameters of Concrete Partially replaced cement by Rice husk ash & Bagasse ash

AnnapurnaB.P[1], Syed Afzaal Gazanfar[2], N. Jayarammappa.N[1]

ABSTRACT

From the previous investigation it has been understood that many engineering properties of the normal concrete can be improved by incorporating agro industrial sites. The present experimental studies are carried out to understand the fresh properties (workability) & hardened properties (compressive strength and flexural Strength parameters) of Concrete partially replacing cement by Rice husk ash (RHA), Bagasse ash (BA) and combination of Bagasse ash & Rice husk ash(BA+RHA) with six different replacement levels of 5%, 10%, 15% , 20 % 25% and 30%.The concretes partially replaced by Rice husk ash (RHA), Bagasse ash (BA) and combination of Bagasse ash & Rice husk ash(BA+RHA) are designated as Rice husk ash concrete (RHAC), Bagasse ash concrete (BAC) and Bagasse ash + Rice husk ash concrete (BA+RHAC) respectively and for 0% replacement (no replacement) the concrete is designated as normal concrete(NC).The study is carried out for two grades of concrete of M25 and M70. The hardened properties (compressive strength and flexural Strength parameters) of M25 and M70 grade of concrete are studied on specimen cured for 56 days.Tostudy the effect of curing period on strength of concrete the compressive strength of M25 grade concrete is studied on specimen cured for 28 days and 56 days .For the study of compressive strengthens and flexural strengths Cube specimens of 150x150x150 mm and prisms specimen of size 100x100x500 mm are casted respectively. The RHAC (Rice husk ash concrete) achieves higher strength,BAC (Bagasse ash concrete) achieves least strength. ForM25 concrete the replacement of cement by Rice husk ash (RHA), Bagasse ash (BA) and combination of Bagasse ash & Rice husk ash(BA+RHA) up to 15% is advantageous as the strength is higher than normal concrete. ForM70 concrete, replacement of cement by Rice husk ash (RHA), Bagasse ash (BA) and combination of Bagasse ash & Rice husk ash(BA+RHA) up to 10% is satisfactory as it achieves a strength of 85% to 80% of normal concrete.

KEYWORDS: rice husk ash (RHA), bagasse ash (BA), combination of Bagasse ash & Rice husk ash (BA+RHA), , normal concrete(NC), rice husk ash concrete(RHAC), Bagasse ash Concrete(BAC), Bagasse ash +rice husk ash concrete(BA+RHAC)

1 INTRODUCTION

Concrete is the second most used material on earth (after water), and is the most common and widely used construction material in the world. The production of cement adds pollution to environment is a well-known fact to civil engineers and environmentalists.

[1] Asst. Professor, Dept. of Civil Engg. ,UVCE, Bangalore University, Bangalore-560056, Karnataka, India
Email : annapurna_bpuvce@rediffmail.com,
Mob. No: +91-9448558267
[2] PG student, Dept. of Civil Engg., UVCE, Bangalore University, Bangalore-560056, Karnataka, India

The large-scale production of cement is posing environmental problems on one hand and unrestricted depletion of natural resources on the other hand. Alternative materials generally used are mainly the industrial sites which face the problem of safe disposal and cause environment hazards. In the construction industry, concrete technology is heading towards entirely new era by way of using pozolona material like Rice husk ash and Bagasse ash in concrete.

The rice husk is a byproduct of rice mill, this rice husk is used as a as fuel for boilers in the rice mill, the ash obtained after burning of the rice husk is rice husk ash (RHA) . RHA contains about 90% to 95 % silica, which is a highly pozolonaic material and can be used as cement replacement in concrete. It is learnt that, in order to produce RHA , a specific set of temperatures and duration of burning has to be maintained. And the form of silica obtained after

combustion of RHA depends on the temperature and duration of combustion of rice husk. However the RHA obtained from the rice mill is of huge quantity which can be used as the replacement to cement . Hence the objective of this paper is to present the effect of partially replaced cement by the available RHA, which is burnt under uncontrolled temperature. The RHA used in this study contains 91% silica content

Bagasse is a byproduct of sugar industry where in bagasse (stem of sugar cane after the extraction of the juice) obtained after the processing of sugarcane is fed in to the boilers to act as fuel in the same industry, which is burnt under uncontrolled temperature. The ash obtained after burning of the bagasse is the bagasse ash(BA). BA used in this study contains 61% silica content

2 EXPERIMENTAL INVESTIGATION

In the present paper the strength parameters of M25 and M70 grade of concrete, partially replacing cement by Rice husk ash (RHA), Bagasse ash (BA) and combination of Bagasse ash & Rice husk ash(BA+RHA) by varying percentage of 5%, 10%, 15%, 20%, 25% and 30% are presented .The concrete partially replaced by RHA, BA and combination of BA+ RHA are designated as the Rice husk ash concrete (RHAC),Bagasse ash concrete (BAC) and Bagasse ash & Rice husk ash concrete (BA+RHAC). Obtained Strengths are compared with Normal concrete (NC) (0% replacement).The strength parameters are studied on 56 days aged specimens. Also to study the effect of period of curing on strength of concrete the compressive strength of M25 grade concrete is tested on specimen cured for both 28 and 56 days. For the study of compressive strength and flexural strength, cube specimens of 150x150x150 mm and prism specimens of size 100x100x500 mm are casted respectively.

3 MATERIALS USED

3.1 Cement

In the present investigation Ordinary Portland Cement of 53gradeis used. Tests are conducted in accordance with the Indian standards confirming to IS-12269:1987.

3.2 Fine aggregate

Locally available clean river sand is used as fine aggregate in present investigation, the finess modulus of Fine aggregate is 2.855.

3.3 Coarse aggregate

Coarse aggregate of crushed granite of size 12.5mm maximum size and retained on IS 480 sieves obtained from the stone crusher near Ramanagara, Karnataka, India.

3.4 Water

Locally available clean potable water is used for mixing and curing of concrete, a constant W/C ratio of 0.45 and 0.30 is maintained for M25 and M70 grade concretes respectively.

3.5 Rice husk ash (RHA)

Rice husk ash is collected and brought from Lakshmi rice mill in Bangalore. The fineness of obtained rice husk ash is 150 micron down .Finesse and Chemical composition of Rice husk ash is as tabulated inTable1 and 2.

3.6 Bagasse ash (BA)

Bagasse ash is collected and brought from Swathi Jaggery factory in Mandya district, Karnataka, India. The fineness of obtained bagasse ash is 300 micron down. Finesse and Chemical composition of Bagasse ash is tabulated in Table1 and 2.

3.7 Super plasticizer

Super plasticizer conforming to IS: 9103 /1999 Type “G” (Conplast SP-430 a product from FOSROC) is used to maintain the workability of M70 grade concrete without increasing water demand. A constant dosage of 1% is maintained.

Table-1: Fineness of admixture

Admixture	Rice Husk Ash	Bagasse Ash
Fineness	150 micron	300 micron

Table-2: Chemical composition of Rice Husk Ash and Bagasse Ash

Sl. No	Percentage by mass	RESULTS	
		RHA	BA
1	Loss on ignition (LOI)	24.03	6.79
2	(Sio_2),	91.06	68.03
3	(Mgo)	0.95	1.21
4	(Al_20_3)+ (Fe_2o_3)	2.62	20.08
5	(Cao)	2.78	9.15

4 MIXING OF CONCRETE

Firstly the admixtures (RHA or BA or BA+RHA) and cement is thoroughly mixed in a mixer, later fine aggregate and coarse aggregate are added and mixed well without water. Water is then added and thoroughly mixed. The mixed concrete is poured in to the standard cube and prism mould and well compacted. The concrete cubes are then de-moulded after 24 hours and placed in water for curing, for required period.

The mix proportion for M25 and M70 grade of concrete are given in table 3 and 4.

Table-3: Mix proportions of M_{25} graded NC, RHAC, BAC and BA+RHAC

Sl. No	Concrete	Designation	Mix proportion (weight in, Kg/m^3)					
			Binding material			Aggregates		W/b 0.45 Water in liters
						Fine	Coarse	
			Cement	RHA	BA	Sand Total	12.5 mm down	
1	Normal Concrete	NC	466	-	-	780.32	920.86	210
2	RHAC	RHAC5	442.7	23.3	0	780.32	920.86	210
3		RHAC10	419.4	46.6	0	780.32	920.86	210
4		RHAC15	396.1	69.9	0	780.32	920.86	210
5		RHAC20	372.8	93.2	0	780.32	920.86	210
6		RHAC25	349.5	116.5	0	780.32	920.86	210
7		RHAC30	326.2	139.8	0	780.32	920.86	210
8	BAC	BAC5	442.7	0	23.3	780.32	920.86	210
9		BAC10	419.4	0	46.6	780.32	920.86	210
10		BAC15	396.1	0	69.9	780.32	920.86	210
11		BAC20	372.8	0	93.2	780.32	920.86	210
12		BAC25	349.5	0	116.5	780.32	920.86	210
13		BAC30	326.2	0	139.8	780.32	920.86	210
14	BA+ RHAC	BA+RHAC5	442.7	11.65	11.65	780.32	920.86	210
15		BA+RHAC10	419.4	23.3	23.3	780.32	920.86	210
16		BA+RHAC15	396.1	34.95	34.95	780.32	920.86	210
17		BA+RHAC20	372.8	46.6	46.6	780.32	920.86	210
18		BA+RHAC25	349.5	58.25	58.25	780.32	920.86	210
19		BA+RHAC30	326.2	69.9	69.9	780.32	920.86	210

Table-4: Mix proportions of M_{70} graded NC, RHAC, BAC and BA+RHAC

Sl. No	Concrete	Designation	Mix proportion (weight in, Kg/m^3)					
			Binding material			Aggregates		W/b 0.45 Water in liters
						Fine	Coarse	
			Cement	RHA	BA	Sand Total	12.5 mm down	
1	Normal Concrete	NC	585.13	-	-	424.9	1272.65	175.8
2	RHAC	RHAC5	555.88	29.25	-	424.9	1272.65	175.8
3		RHAC10	526.62	58.51	-	424.9	1272.65	175.8
4		RHAC15	497.36	97.35	-	424.9	1272.65	175.8
5		RHAC20	519.20	129.80	-	424.9	1272.65	175.8
6		RHAC25	438.75	146.25	-	424.9	1272.65	175.8
7		RHAC30	409.59	175.53	-	424.9	1272.65	175.8
8	BAC	BAC5	555.88	-	29.25	424.9	1272.65	175.8
9		BAC10	526.62	-	58.51	424.9	1272.65	175.8
10		BAC15	497.36	-	97.35	424.9	1272.65	175.8
11		BAC20	519.20	-	129.80	424.9	1272.65	175.8
12		BAC25	438.75	-	146.25	424.9	1272.65	175.8
13		BAC30	409.59	-	175.53	424.9	1272.65	175.8
14	BA+ RHAC	BA+RHAC5	409.59	14.625	14.625	424.9	1272.65	175.8
15		BA+RHAC10	526.62	29.075	29.075	424.9	1272.65	175.8
16		BA+RHAC15	497.36	48.675	48.675	424.9	1272.65	175.8
17		BA+RHAC20	519.20	64.9	64.9	424.9	1272.65	175.8
18		BA+RHAC25	438.75	73.125	73.125	424.9	1272.65	175.8
19		BA+RHAC30	409.59	87.765	87.765	424.9	1272.65	175.8

5 RESULTS AND DISSCUSIONS

5.1 FRESH PROPERTY

5.1.1 Workability

The workability is measured by using slump test. The values of slump of RHAC, BAC and BA+RHAC for different replacement levels of 0%,5%, 10%, 15%, 20%, 25% and 30% of RHA, BA and combination of BA and RHA with **constant water/binder ratio,** for M25 and M70 grade concrete, are presented in Fig. 1a,b and c.

- As the percentage replacement of cement by RHA or BA ash increased, the slump value decreased, reducing the workability of concrete.
- When the slump values of concrete with different percentage of RHA or BA or BA + RHA are compared, concrete with BA showed marginal increase in slump indicating better workability compared to that of concrete with RHA and BA+ RHA.
- The Concrete with replacement of RHA or BA or BA + RHA above
- 20% showed low slump values indicating very low workability.
- For M70 grade concrete (w/c=0.3) the slump values are higher than M25 grade concrete (w/c=0.45) this may be due to the addition of superplasticizer.
- For higher replacement levels there is need for superplasticizer to maintain the workability.

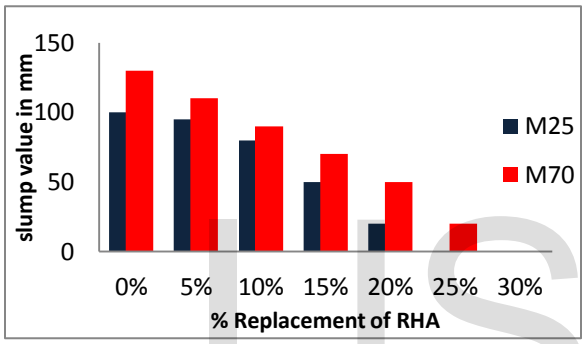


Fig.a:RHAC

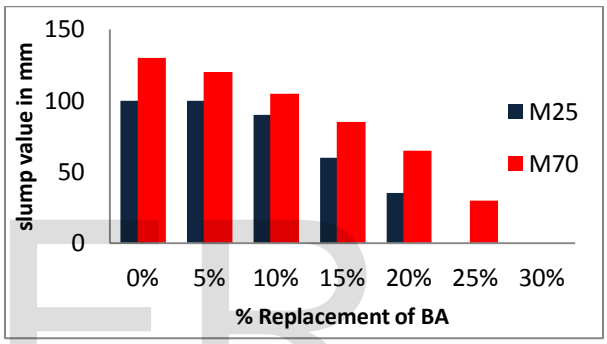


Fig.b:BAC

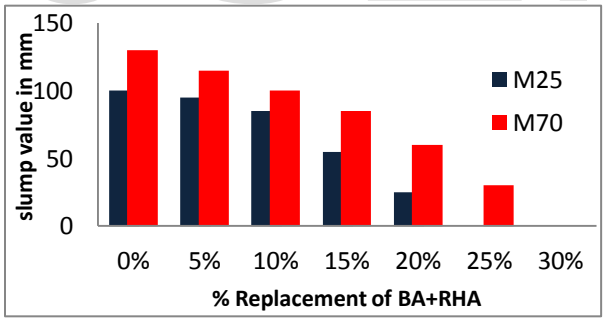


Fig.c:BA+RHAC

Fig.1: Slump value of concretes of grade M25 and M70

5.2 HARDENED PROPERTIES.

5.2.1.1 Weights of concrete cubes

- The weights of concrete cubes of M25 and M70 grade concretes cured for 56 days are presented in Fig 2.
- The weights of M25grade concrete of RHAC, BAC and BA+RHAC for different percentage replacement levels of (5%, 10%, 15%, 20%, 25% and 30%) RHA, BA and BA+RHA, varied from 8.19 to 7.34 Kg, 8.23 to 7.77 kg and 8.22 to 7.73 kg respectively where as the weight of normal concrete (0% replacement) is 8.3 Kg.
- There is a reduction in the weights of concrete cubes(M25grade concrete) with increase in percentage replacement of RHA, BA and BA+RHA the lowest weights of 30% replacement of RHA, BA, BA+RHA are 7.34 Kg, 7.77 kg and 7.73 kg respectively which are almost 12%, 6% and 7% less than normal concrete.
- For M70 grade concrete of RHAC, BAC and BA+RHAC the weights of the admixture concretes varied from 8.6 to 7.5 Kg, 8.78 to 8 kg and 8.7 to 7.9 kg respectively, and the weight of normal concrete is 8.9 Kg.
- The highest reduction in weights for RHAC, BAC and BA+RHAC of M70 grade for the 30% replacement are 7.5 Kg, 8 kg and 7.9 kg, which are almost 16%, 12% and 11% less than normal concrete.
- The reductions in weights of the RHAC are greater than BAC and BA+RHAC for both M25 and M70 grade concretes in comparison to NC.
- The weights of BA+RHAC are less than BAC, but there is not much significant difference between weights of BAC and BA+RHAC.

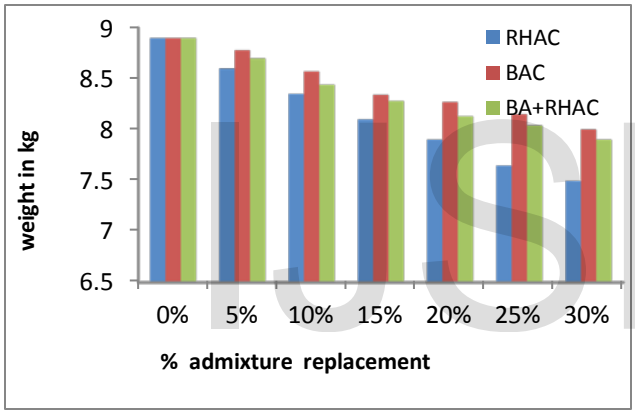


Fig. a: M25 grade concrete

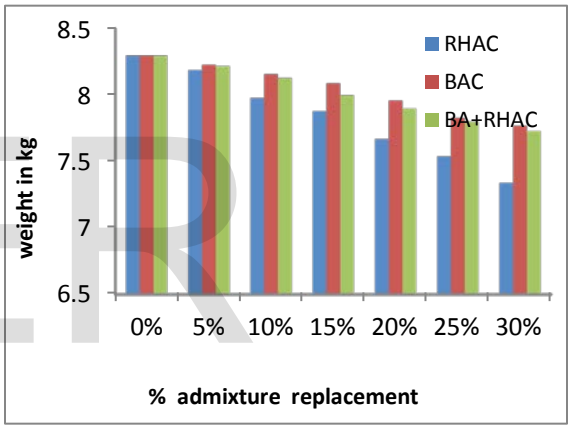


Fig.b: M70 grade concrete

Fig .2: Weights of concretes cubes

5.2.2 Effect of Curing

- The strength of NC at curing period of 28 days and 56 days are 26.15 N/mm^2 and 27.55 N/mm^2(Fig.3)
- The strength of 28 days cured RHAC for replacement levels from 5% to 30% varied from 25.77 N/mm^2 to 12.44 N/mm^2 respectively. At 56 days of curing the Compressive strength of RHA concrete of 5%, 10% and 15% replacements are 31.11 N/mm^2, 34.68 N/mm^2 and 30.22 N/mm^2 respectively and further increase in percentage of RHA from 20% to 30%, the RHAC concrete achieved compressive strength of 22.22 N/mm^2 to 12.4 N/mm^2(Fig.3).
- The strength of BAC for replacement levels from 5% to 30% varied from 24 N/mm^2 to 11.55 N/mm^2 respectively for 28 days curing. At 56daysof curing the Compressive strength of BA concrete of 5%, 10% and 15% replacements are 28.5 N/mm^2, 31.5 N/mm^2 and 27.55 N/mm^2 respectively and further increase in percentage of BA (20% to 30%), the BAC concrete achieved compressive strength of 22.22 N/mm^2 to 12.4 N/mm^2 (Fig.3).
- The strength of BA+RHAC for replacement levels from 5% to 30% varied from 24 N/mm^2 to 11.55 N/mm^2 respectively for 28 days of curing. At 56days of curing the Compressive strength of BA+RHA concrete of 5%, 10% and 15% replacement are29.33 N/mm^2, 32 N/mm^2 and 28.5 N/mm^2 respectively and further increase in percentage of BA+RHAC from 20% to 30%, the RHAC concrete achieved compressive strength of 22.22 N/mm^2 to 15 N/mm^2 (Fig.3).
- Compressive strength achieved by the NC for 28 days of curing is 95%.

- For an optimum percentage replacement of RHA,BA and BA+RHA of 10% the compressive strength achieved at 28 days of curing compared to 56 days of curing are on an average of 65%
- For all RHAC or BAC or BA+RHAC attains significant strength only after 56 days of curing compared to Normal concrete which attains significant strength at 28days curing.

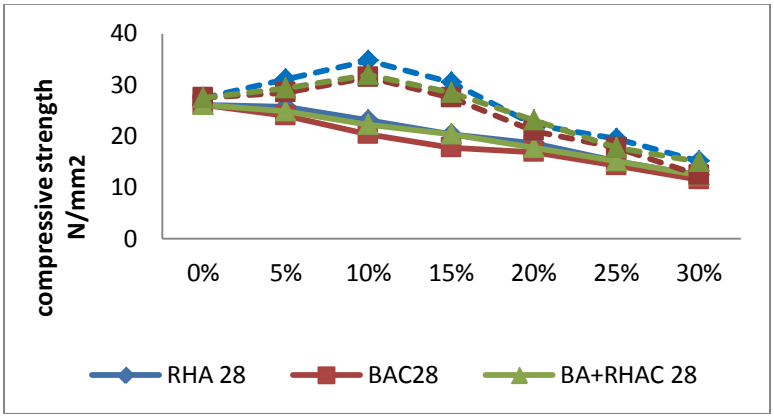


Fig .3: Compressive strength of M25 grade concrete cured for 28 and 56 days

5.2.3 Compressive strength

5.2.3.1 M25 Grade Concrete

- Compressive strengths of M25 grade concretes of NC, RHAC, BAC and BA+RHAC for varying percentages replacements of RHA, BA and BA+RHA are shown in Fig.4
- Compressive strength of NC is 27.55 N/mm^2 .
- Compressive strengths of RHA concrete of 5%, 10% and 15% replacement of RHA are 31.11 N/mm^2, 34.68 N/mm^2 and 30.22 N/mm^2 respectively, which are 1.12, 1.25 and 1.096 times of normal concrete. Further increase in percentage of RHA, 20% to 30%, the compressive strength of RHAC varied from 22.2 N/mm^2 to 15.15 N/mm^{2}respectively, which are 0.806 to 0.55 timesof normal concrete.
- Compressive strength of BA concrete of 5%, 10% and 15% replacement are 28.5 N/mm^2, 31.5 N/mm^2 and 27.55 N/mm^2 respectively, which are 1.034, 1.143 and 1 times of normal concrete. But further increase in percentage of BA, 20% to 30%, the compressive strength of BAC varied from 22.22 N/mm^2 to 12.4 N/mm^2, which are 0.68 to 0.45 times that of normal concrete.
- Compressive strength of BA+RHA concrete of 5%, 10% and 15% replacement are 29.33 N/mm^2, 32 N/mm^{2}and 28.5 N/mm^{2}respectively, which are 1.064, 1.161 and 1.034 times of normal concrete respectively. Further increase in percentage of BA+RHA, 20% to 30%, the compressive strength of BA+RHAC varied from 23.1 N/mm^2 to 15 N/mm^2, which are 0.84 to 0.54 times of normal concrete.
- Compressive strength of concrete reached peak value at10% replacements and from 15% to 30% replacements there is a gradual reduction in compressive strength of RHAC or BAC or BA+RHAC. However, upto 15% the compressive strength of RHAC, BAC and BA+RHAC are higher than normal concrete.
- Among RHAC, BAC & BA+RHAC, RHAC achieved highest compressive strength and BAC achieved least.
- Compressive strength of BA+RHAC is 2% higher than BAC and 8% lesser than RHAC (for 10% replacement).

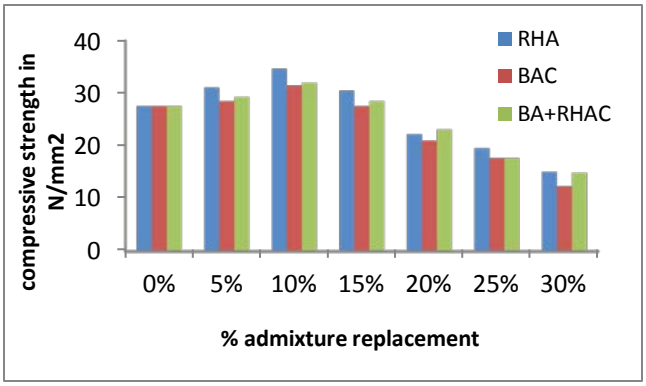


Fig .4: Compressive strengths of M25 grade concrete (56 days of curing)

5.2.3.2 M70 Grade Concrete

- Compressive strengths of M70 grade concretes of NC, RHAC, BAC and BA+RHAC for varying percentages replacements of RHA, BA and BA+RHA are shown in Fig.5
- Compressive strength of RHAC with replacement of RHA, 5% to 30% varied from 62.66 N/mm^2, to 26.66 N/mm^2 respectively and in terms of ratio varied from 0.875 to 0.372 respectively in comparison to compressive strength of normal concrete of 71.55 N/mm^2.
- Compressive strength of BAC with replacement of BA, 5% to 30% varied from 54.22 N/mm^2, to 21.33 N/mm^2 respectively, in terms of ratio varied from 0.757 to 0.298 respectively in comparison to compressive strength of normal concrete of 71.55 N/mm^2 .
- Compressive strength of BA+RHAC with replacement of BA+RHA, 5% to 30% varied from 59.11 N/mm^2, to 24.44 N/mm^2 respectively, in terms of ratio varied from 0.826 to 0.341 respectively in comparison to compressive strength of normal concrete of 71.55 N/mm^2.
- At 10% replacements, the compressive strengths, of RHAC are 85%, BA+RHAC is 80% and BAC is 70%.
- Among RHAC, BAC & BA+RHAC, RHAC achieved highest compressive strength and BAC achieved least. The compressive strength of BA+RHAC is 5% higher than BAC and 11% lesser than RHAC (for 10% replacement).

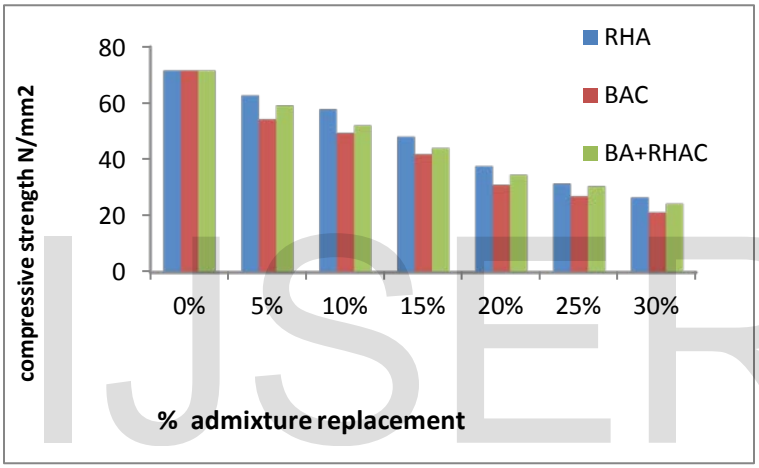


Fig 5: Compressive strength of M70 grade concrete (56 days of curing)

5.2.4 Flexural strength

5.2.4.1 M25 Grade concrete

- Flexural strengths of M25 grade concretes of RHAC, BAC and BA+RHAC for varying percentages replacements of RHA, BA and BA+RHA are shown in Fig.6
- Flexural strength of NC is 5.6 N/mm^2 .
- The flexural strengths of RHA C of 5%, 10%, 10%, 15% and 20% replacements are 8 N/mm^2, 8.4 N/mm^2, 7.2 N/mm^2 and 5.6 N/mm^2 respectively, which are 1.428, 1.5, 1.285 and 1 times of normal concrete respectively. Further increase in percentage of RHA to 25% and 30%, the RHAC concrete achieved flexural strength of 4.8 N/mm^2 and 4.4 N/mm^2, which are 0.857 and 0.785 times of normal concrete.
- The flexural strength of BAC of 5%, 10% and 15% replacements are 6.8 N/mm^2, 7.2 N/mm^2 and 6 N/mm^2 respectively, which are 1.214, 1.285 and 1.071 times of normal concrete respectively, But further increase in percentage of BA to 20%, 25% and 30%, the BAC concrete achieved flexural strength of 4.4 N/mm^2, 3.6 N/mm^2 and 3.2 N/mm^2, which are 0.785, 0.642 and 0.517 times of normal concrete.
- The flexural strength of BA+RHAC of 5%, 10% and 15% replacements are7.2 N/mm^2, 8 N/mm^2 and 6.4 N/mm^2 respectively, which are 1.285, 1.428 and 1.142 times more than that of normal concrete respectively, But further increase in percentage of BA+RHA to 20%,25% & 30%, the BA+RHAC achieved flexural strength of 4.8 N/mm^2, 4 N/mm^2 and 3.6 N/mm^2, which are 0.856, 0.714 and 0.642 times less than that of normal concrete.
- The flexural strength of concrete reached peak value at 10% replacements and from 15% to 30%replacements there is a gradual reduction in compressive strength of RHAC or BAC or BA+RHAC.
- Among the RHAC, BAC & BA+RHAC, RHAC achieves highest flexural strength and BAC achieves least. The flexural strength of BA+RHAC is 11% higher than BAC and 5% lesser than RHAC (for 10% replacement).

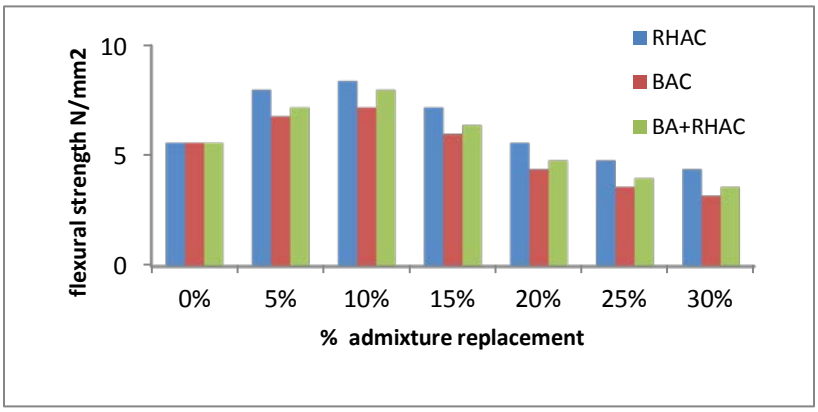


Fig.6:Flexural strengths of M25 grade concrete.

5.2.4.2 M70 Grade concrete

- Flexural strengths of M70 grade concretes of RHAC, BAC and BA+RHAC for varying percentages replacements of RHA, BA and BA+RHA are shown in Fig.7
- The flexural strengths of RHAC for different levels from 5% to 30% of RHA replacement varied from 14.4 N/mm^2, to 4 N/mm^2 (0.9 to 0.437 times the NC) compared to the flexural strength of NC which is 16 N/mm^2..
- The flexural strengths of BAC for different levels from 5% to 30% of BA replacement varied from 10 N/mm^2, to 3.2 N/mm^2 (0.625 to 0.2 times the NC) compared to the flexural strength of NC of 16 N/mm^2..
- The flexural strength of BA+RHAC for different levels from 5% to 30% of BA+RHA replacement varies from 12.5 N/mm^2, to 4 N/mm^2 (0.775 to 0.25 times the NC) compared to the flexural strength of NC of 16 N/mm^2.
- The flexural strength of BA+RHAC is 25% higher than BAC and 11% lesser than RHAC (for 10% replacement).

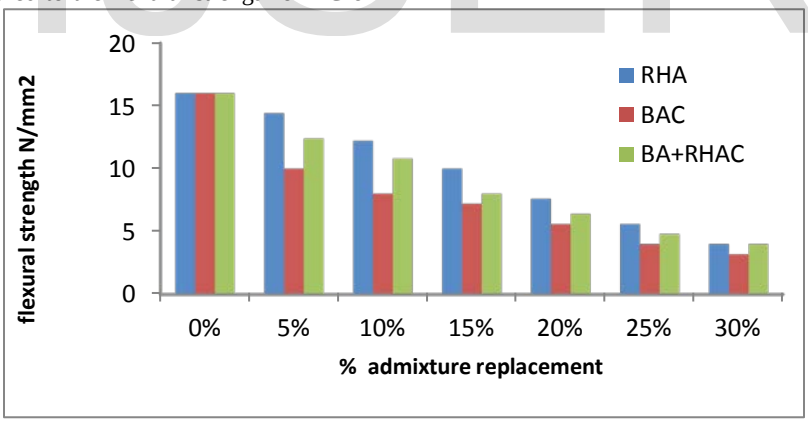


Fig.7: Flexural strengths of M70 Grade Concretes

5.2.4.3 Comparison of compressive strength &Flexural strengths of M25 and M70 grade concrete

- Comparison of Compressive strength and Flexural strengths of M25 and M70 grade concretes of RHAC, BAC and BA+RHAC for varying percentage replacements of RHA, BA and BA+RHA are shown in Fig.8 and 9
- In case of low grade concrete, M25 grade concrete with partial replacement of cement by RHA or BA or BA+RHA up to 15% gives higher strength than normal concrete.
- In case of higher grade concrete,M70 grade concrete, with partial replacement of cement by RHA or BA or BA+RHA the strength of concretes gets reduced than NC for all percentage replacement levels of RHA or BA or BA+RHA from 5% to 30% . However upto 10% replacements the strength of concrete gets reduced by 15% to 20%of NC.

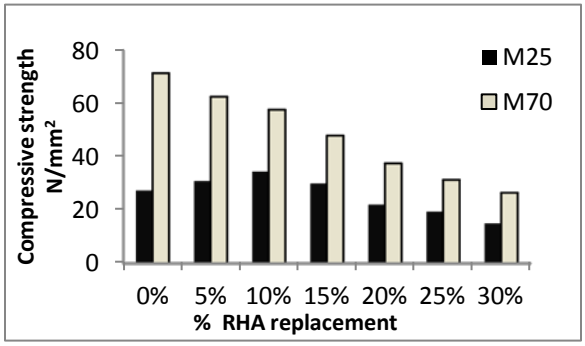


Fig.a: RHAC

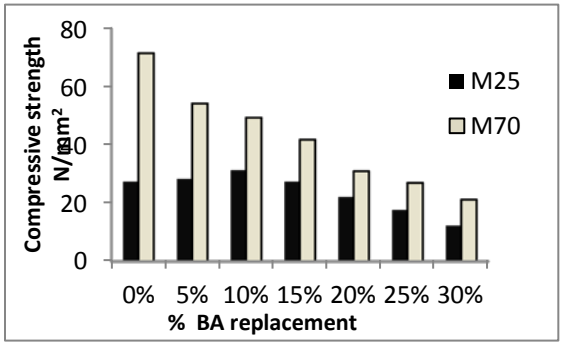


Fig.b: BAC

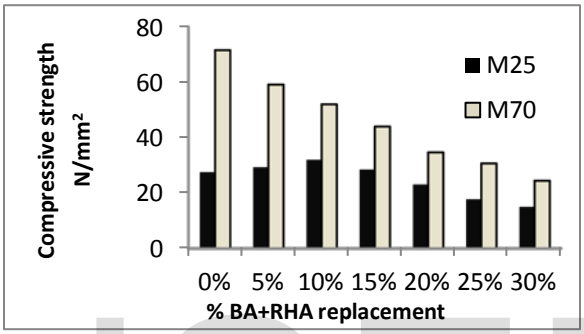
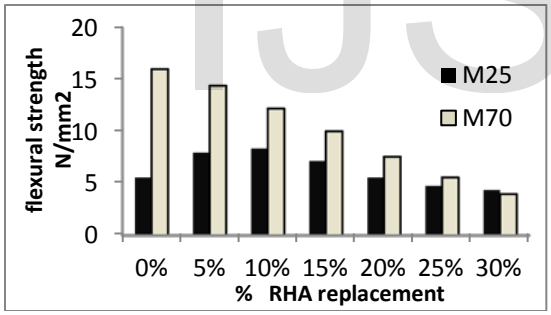


Fig.c : BA+RHAC

Fig 8: Comparison of Compressive strengths of Concretes of M25 and M70 grade



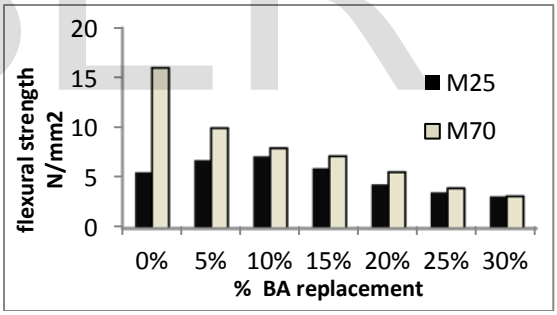


Fig.a:RHAC **Fig.b: BAC**

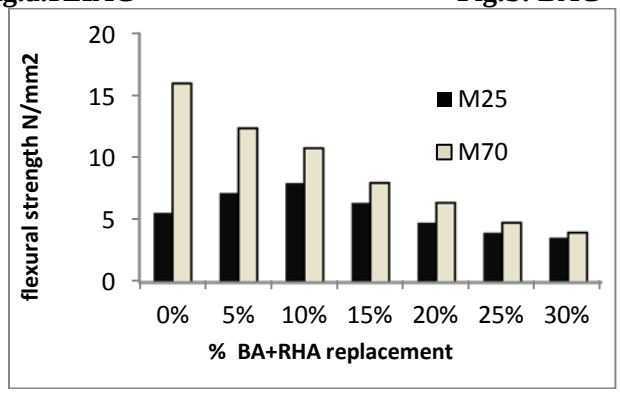


Fig.c: BA+RHAC

Fig.9: Flexural strengths of Concretes of M25 and M70 grade

6 CONCLUSIONS

- The partial replacement of cement with RHA or BA or BA+RHA up to 15% in case of low grade concrete (M25 grade) is advantageous compared to NC.
- For higher grade concrete (M70) with partial replacement of cement with RHA or BA or BA+RHA the strength gets reduced even for 5% replacements compared to NC, however up to 10% replacement the strength gets reduced by an average of 15%. Hence for a mix design of M70 grade concrete with replacement by RHA, or BA or BA+RHA upto 10%, achieves strength equal to M60 mix designee
- For higher grade concrete (M70) with partial replacement of cement with RHA or BA or BA+RHA up to 10% is satisfactory.
- RHAC compared to BAC & BA+RHAC is lighter and achieved higher strength.
- RHAC and BA+RHAC upto 15% replacements (M25 grade concrete) showed higher strength than Normal Concrete.

7 REFERENCES

1. M.R. Karim, M.F.M. Zain, M. Jamil, F.C. Lai and 3M.N. Islam, '**Strength of Mortar and Concrete as Influenced by Rice Husk Ash: A Review**'. World Applied Sciences Journal 19 (10): 1501-1513, 2012.
2. AbhilashShukla, C. K. Singh and Arbind Kumar Sharma, '**Study of the Properties of Concrete by Partial Replacement of Ordinary Portland Cement by Rice Husk Ash'.**International Journal of Earth Sciences and Engineering ISSN 0974-5904, Volume 04, No 06 SPL, October 2011, pp. 965-968
3. Akinwonmi, Ademola Samuel and Seckley, Emmanuel, '**Fracture Behaviour Of Concrete With Rice Husk Ash Replacement Under Uniaxial Compressive Loading'** Research Journal in Engineering and Applied Sciences 2(2) 132-136 © Emerging Academy Resources (2013) (ISSN: 2276-8467).
4. Satish D. Kene, Pravin V. Domke, Sandesh D. Deshmukh3, R.S.Deotale. '**Assessment Of Concrete Strength Using Flyash And Rice Husk Ash'**,Engineering Research and Applications (IJERA)Vol.1, Issue 3, pp.524-534.
5. G. C. Cordeiro, R. D. Toledo filho and E. M. R. Fairbairn, '**Ultrafine sugar cane bagasse ash: high potential pozzolanic material for tropical countries'.** IBRACON Structures and Materials Journal • 2010 • vol. 3 p. 50 – 67.
6. R.Srinivasan and K.Sathiya, '**Experimental Study on Bagasse Ash in Concrete',** International Journal for Service Learning in Engineering Vol. 5, No. 2, pp. 60-66, Feb 2010.
7. Godwin A. Akeke, Maurice E. Ephraim, Akobo, I.Z.S and Joseph O. Ukpata.., '**Structural Properties Of Rice Husk Ash Concrete',**International Journal of Engineering and Applied Sciences. Vol. 3, No. 3, May 2013 .
8. H. S. Otuoze, Y. D. Amartey, B. H. Sada, H. A. Ahmed, M. I. Sanni and M. ASuleiman, '**Characterization Of Sugar Cane Bagasse Ash And Ordinary Portland Cement Blends In Concrete**'.W. (Eds) Procs 4th West Africa Built EnvironmentResearch (WABER) Conference, 24-26 July 2012, Abuja, Nigeria, 1231-1237.
9. S. Suvimol and C. Daungruedeer, '**Bagasse Ash: Effect Of Pozzolanic Activity And Application In Cement Use Aspect',**The 3rd ACF International Conference-ACF/VCA 2008.
10. E.Rama Sai1, Amir Juma1, D.V.A.K.Prakash, Shahbaz Haider1, S.KanakambaraRao,'**An Experimental Study on Synergic Effect of Sugar Cane Bagasse Ash with Rice Husk Ash on Self Compaction Concrete'.** Advances in Computer Science and its Applications (ISSN 2166-2924) 164 Vol. 1, No. 2, 2012.