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AN INVESTIGATION ON THE CHARACTERISTIC PROPERTIES OF SCC USING BAGASSE ASH AND RICE HUSK ASH

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ABSTRACT

Self-compacting concrete (SCC) is one of the type of concrete which will compact by its own weight. Now a day's, due to the increase in cost of cement and sand it is very much important to think for other materials as a replacement of concrete materials. The current trend all over the world is to utilize the treated and untreated industrial by-products, domestic waste etc. as a raw material in concrete. In this present study an attempt has been made to partial replacement of cement by pozzolanic materials like Rice husk ash, Bagasse ash 0%, 10%, 20% and 30% and sand by quarry dust 20%, 30%, 40%, 50% and 70%. Fresh property was done for all the replacement and hardened properties were done at 7, 28 and 56 day for compressive strength, 7, 28 and 91 day for split tensile strength, 7 and 28 day flexural strength. For all levels of cement replacement concrete achieved improve the performance in the fresh and hardened properties should be compared with the reference mix.

Keywords: Self Compacting Concrete, Bagasse ash, Rice husk ash, and quarry dust

I. INTRODUCTION

The development of Self-compacting concrete (SCC) removes the need for compaction when placing of fresh concrete. This saves time, reduces the cost, and improves quality of concrete and working environment [1]. The mix design of SCC must satisfy the criteria on filling ability, passing ability and segregation resistance, these three test methods criteria and limiting values are given [2]. Inert fillers such as limestone are used in SCC mix to increase the powder content [3], these fillers are the moisture variations in concrete, which control shrinkage and creep strain, To design SCC mix by using Nan Su method The dosage of super-plasticizers and viscosity modifying admixture are varied with different values. The Nan-su method is valid for grades more than M50 but with some modifications. It was observed that the flow property is better with metakaolin compared to fly ash or silica fume in all the grades tested. The addition of VMA increases the viscosity of concrete, thereby the flow and filling abilities are improved [6].

SCC mixes always contain a powerful superplastizes and often use a large quantity of powder material and or VMA. The superplastizer is necessary for producing a highly fluid concrete mix, while powder materials or viscosity agent are required to maintain sufficient stability/cohesion of the mix, hence reducing bleeding, segregation and settlement. Increase in the cement content leads to a significant rise in material cost and often other negative effect on concrete properties like shrinkage and chemical attack etc. Sugarcane is one of the major crops grown in most of the countries and its total production is over 1800 million tons all over the world. For each 10 tonnes of sugarcane crushed, a sugar factory produces nearly 3 tonnes of wet bagasse. The utilization of bagasse ash dust and rice husk ash in the concrete, cost saving. Obliviously the material cost depending upon the source [7] The quarry dust is the by-product which is formed in the processing of the granite stones which broken downs into the coarse aggregates of different sizes. Quarry dust has been proposed as an alternative to river sand that gives additional benefit to concrete. In the production of SCC. However, due to its shape and particle size distribution mixes with quarry dust required a higher dosage of superplasticiser to

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achieve similar flow properties. [8]. The M sand is an alternative for sand in the production of SCC, it was observed that relatively higher paste volume is essential to achieve the required flow for SCC using M-sand ,as compared to river sand. Low and medium strength (25–60 MPa) SCCs were achieved by using M-sand. [9] The main objective of this paper study the fresh concrete properties such as filling ability and passing ability and mechanical properties such as compressive strength, split tensile strength, flexural strength of SCC made with up to 30 percent replacement. The results are compared reference mix. [4] proposed a system, this fully automatic vehicle is equipped by micro controller, motor driving mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement to AGV. The speed of rotation of DC motor i.e., velocity of AGV is controlled by the microprocessor controller.This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased.

II. MATERIALS USED

A. Cement

Cement is the fine material which is used as a binding material. Ordinary Portland cement 43 grade was used. It is confirming to the requirement Indian standard specification IS :8112-1989 [10]. The physical properties are given in Table 1. The tests on cement have been carried out as IS : 4031- 1999.

Table 1Properties of Ordinary Portland cement used

Sl. No.	Physical test		Results obtained	Requirement IS: 8112-1989
1	Fineness (retained on 90µm sieve) (%)		5.50	10 maximum
2	Specific gravity		3.05	-
3	Vicat time of setting (minutes)	Initial setting time	80	30 minimum
		Final setting time	325	600 maximum
4	Compressive Strength (MPa)	3 day	24.00	23.00 minimum
		7 day	35.00	33.00minimum
		28 day	45.20	43.00 minimum

B. Fine aggregate

Fine aggregate used in the present study is from the river bed of Hemavathi river Holenarasipur. The sieve analysis of fine aggregate has been carried out as per IS 383-1970[13] and from that it is confirmed to grading zone-II and other properties of fine aggregate are shown in Table 2.

Table 2 Physical Properties of Fine Aggregate, Coarse aggregate and Quarry Dust

Property		Materials		
		Fine Aggregate	Quarry Dust	Coarse Aggregate
Bulk density Kg/m^3	Loose state	1552.00	1520.00	1465.00
	Rodded state	1645.00	1615.00	1595.00
Specific gravity		2.55	2.45	2.62
Fineness modulus		2.97	2.88	6.90
Surface Moisture (%)		1.45	2.35	Nil
Water absorption, %		1.53	2.80	0.15

C. Coarse Aggregate

The common coarse aggregates are crushed stone and gravel. The 16 mm downsize coarse aggregate was and tested as per IS 2386 (I, II, III) specifications and the properties are given in Table 2It is confirming to the requirement Indian standard specification IS : 383-1970[13].

D. Quarry Dust

Quarry dust comprises of the smaller aggregate particles, so it was sieved and quarry dust passing from 4.75mm IS sieve and retaining on 150 micron IS sieve is used for the replacement of fine aggregate. The sieve

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analysis of fine aggregate has been carried out as per IS 383-1970 [13] and from that it is confirmed to grading zone-II and other properties of fine aggregate are shown in Table 2.

E. Water

Generally tap water is used in this experiment. The water which is used should be free from salt. It is very important ingredient in the concrete mass, as it actively participates in a chemical reaction with cement.

F. Rice Husk Ash

The rice husk ash had greyish white colour. RHA was passed through IS 90 micron sieve and this was used. The specific gravity at 27^oC is 2.18 and bulk density is 895 kg/m^3 determined as per IS 1727-1967 [11].

G. Bagasse Ash

The bagasse ash is collected from Hemavathi sugar factory near Channarayapatna (Karnataka state) was used in this study**.**The ash obtained in the factory was coarser and it was put to the ball mill to convert them into fine particles of size most likely to the cement particles. Bagasse ash has grayish white color. Bagasse ash was passed through IS 90 micron sieve and this was used for the research. The specific gravity at 27^oC is 2.32 and bulk density is 1075 kg/m^3 determined as per IS 1727-1967 [11].

H. Chemical Admixture

Admixtures mainly affect the flow behavior of the Self-compacting concrete. The admixture used here is SIKA VISCOCRETE 5231 NS.The properties of this admixture isspecific gravity at 27 ^0C is 1.08, pH is 7.25 and bluish brown colour.

III. MIX PROPORTIONS, PREPARATION AND CASTING OF TEST SPECIMENS

Several trial mixes are prepared by changing the volume ratio of fine aggregate, coarse aggregate, water/powder ratio and super plasticizer. On the basis of the test results many trail mixes are conducted in the laboratory and final mix proportion which satisfies the fresh concrete properties as per EFNARC 2002 [2] guidelines is selected for control concrete mix. The final mix proportion is the reference mix of SCC mixes with different replacement level of bagasse ash, RHA and QD for all the mixes coarse aggregate content is kept constant as shown in Table 3. These mixes are tested as per EFNARC [2] and satisfied their requirements.The mix proportion for SCC mixes are given in Table 3. The test specimens were cast in one layer in steel moulds without any vibration or tamping, the size and shape of the specimens as per IS 516-1959 for each replacements.

Table 3Mix proportion for SCC mixes

Mix Notation	Cement (kg/m^3)	BA (kg/m^3)	RHA (kg/m^3)	FA (kg/m^3)	QD (kg/m^3)	CA (kg/m^3)	W/c ratio	SP (%)
BR1	450	0	0.00	891.00	0.00	742.50	0.46	0.50
BR2	405	22.50	22.50	623.70	267.30	742.50	0.48	0.50
BR3	405	22.50	22.50	534.60	356.40	742.50	0.48	0.50
BR4	405	22.50	22.50	445.50	445.50	742.50	0.5	0.60
BR5	405	22.5	22.5	267.30	623.70	742.50	0.55	0.60
BR6	360	45.00	45.00	623.70	267.30	742.50	0.52	0.55
BR7	360	45.00	45.00	534.60	356.40	742.50	0.52	0.50
BR8	360	45.00	45.00	445.50	445.50	742.50	0.55	0.60
BR9	360	45.00	45.00	267.30	623.70	742.50	0.55	0.60
BR10	315	67.50	67.50	623.70	267.30	742.50	0.53	0.65
BR11	315	67.50	67.50	534.60	356.40	742.50	0.55	0.50
BR12	315	67.50	67.50	445.50	445.50	742.50	0.55	0.70
BR13	315	67.50	67.50	267.30	623.70	742.50	0.55	0.65

IV. TESTING OF SPECIMENS

The fresh concrete properties such as filling ability and passing ability (Slump flow test, Slumpflow$T_{50\ cm}$,J-ring test,V-funnel test and L box were carried out according to EFNARC [2]. Hardened concrete properties such as compressive strength, split tensile strength and flexural strength [13] each mixtures of SCC testing.

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V. RESULTS AND DISCUSSION

A. Fresh Concrete Properties

Table 4Fresh concrete properties of SCC Mixes

Mix Notation	Slump Flow (mm)	$T_{50\ cm}$ Slump Flow(sec)	J Ring (mm)	V- funnel (sec)	L-Box
BR1	640	7	9	8	0.83
BR2	649	5	8.5	11	0.87
BR3	630	7	5	10	0.81
BR4	605	7	5	11	0.92
BR5	690	5	8	10	0.93
BR6	590	7	14	14	0.85
BR7	630	5	6	10	0.85
BR8	645	6	9	10	0.82
BR9	650	6	10	10	0.89
BR10	613	7	12	12	0.86
BR11	650	7	5	12	0.91
BR12	654	5	8	11	0.82
BR13	652	6	9	10	0.80

From the above Table 4, it can be seen that the control mix got 640 mm slump flow. As the replacement of cement increase, the slump flow also increases. The slump flow value obtained maximum is 690 mm for BR5, i.e. 10% replacement of cement and 70% replacement of fine aggregate. The slump flow values of various mixtures were between 590 mm to 690 mm, a slump flow between 650 mm to 800 mm [2], which are an indication of a good deformability. Based on the slump flow and visual observation, SCC property for all mixtures was found to be satisfactory.Here the control mix had a 7 seconds of $T_{50\ cm}$ slump flow time and BR2, BR5, BR7 and BR12are having 5 seconds of $T_{50\ cm}$ slump flow time. They have shown better result compared to all other mixes.From the above table in L box it can be seen that the control cube is having depth ratio 0.83 and all other replacements are satisfied according to EFNARC. From the above table in V funnel test, it can be seen that the control mix is shown 8 seconds. BR6 having 14 sec. does not satisfies for acceptable limit and all other mix as shows better results.From the above table J ring test, it can be seen that the control mix got 9 mm depth.BR8 and BR13 does not satisfied for acceptable limit and all other mixes shows better results. The acceptable difference as per available literature is 0-10 mm.

B. Mechanical properties

1. Compressive strength

The results of compressive strength of cubes for 7, 28 and 56 day curing are given in Table 5. Also results are compared graphically in Fig. 1.

Table 5 Compressive strength of SCC mixes

Mix Notation	Experimental Compressive Strength (MPa)		
	7 Day	28 Day	56 Day
BR1	28.17	42.17	45.96
BR2	27.15	32.83	35.11
BR3	26.58	37.17	42.85
BR4	27.86	40.92	43.45
BR5	27.15	38.98	41.00
BR6	19.42	26.52	28.91
BR7	21.84	25.17	28.56
BR8	19.40	25.93	29.12
BR9	18.80	24.93	28.71

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BR10	16.38	23.20	24.53
BR11	16.08	21.93	23.29
BR12	14.33	18.95	20.70
BR13	12.35	17.26	20.22

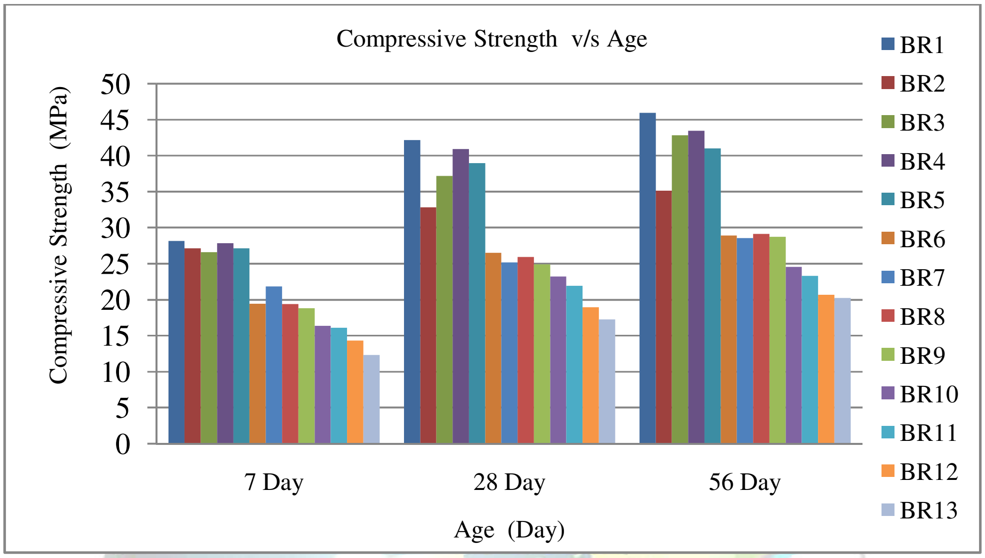

Fig. 1 Variation of Compressive Strength of Cubes with Age

It can be seen from Fig. 1 the compressive strength increased with a decrease in the percentage of the bagasse ash and RHA at all levels of replacement at 7, 28 and 56days and an increase trend strength is observed as the age of concrete increases. The reductions of compressive strength are 3.76 % to 56.15 % for 7 day, 2.96% to 59.07 % for 28 day, 5.46 to 56.07 % for 56 days compared with control mix. In the early age bagasse ash and RHA reacts slowly with calcium hydroxide liberated during hydration of cement and does not contribute significantly to the densification of concrete matrix. It can be seen from the Fig. 1up to the age of 28 days, there was progressive improvement.The mix BR5 achieved 40.92 MPa. This can be mainly due to silica and Calcium oxide content. The compressive strength was strongly affected by water cement ratio and filler types. Hence, 10 % replacement of cement by bagasse ash and RHA and 50 % replacement of sand by quarry dust can be taken as optimum replacement in suceesive ages of tests taken into consideartion.

2. Split Tensile Strength

The results of split tensile strength of cylinder for 7,28 and 91 day curing are given in Table 6. Also results are compared graphically in Fig. 2.

Table 6 Split Tensile Strength and Flexural Strength of SCC Mixes

Mix Notation	Split Tensile Strength (MPa)			Flexural Strength (MPa)	
	7 day	28 day	91 day	7 Day	28 Day
BR1	2.22	3.28	3.96	2.54	3.65
BR2	2	2.55	3.01	2.18	2.97
BR3	1.85	2.85	3.08	2.10	2.76
BR4	2.08	2.88	3.54	2.08	2.87
BR5	1.52	2.59	3.02	1.87	2.56
BR6	1.66	2.25	2.68	1.70	2.36

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BR7	1.51	2.2	2.61	1.66	2.22
BR8	1.51	2.2	2.61	1.53	2.15
BR9	1.33	1.91	2.48	1.60	2.21
BR10	1.19	1.67	2.08	1.50	2.01
BR11	1.19	1.67	2.08	1.43	1.98
BR12	1.19	1.65	1.91	1.46	1.93
BR13	1.05	1.57	1.91	1.29	1.94

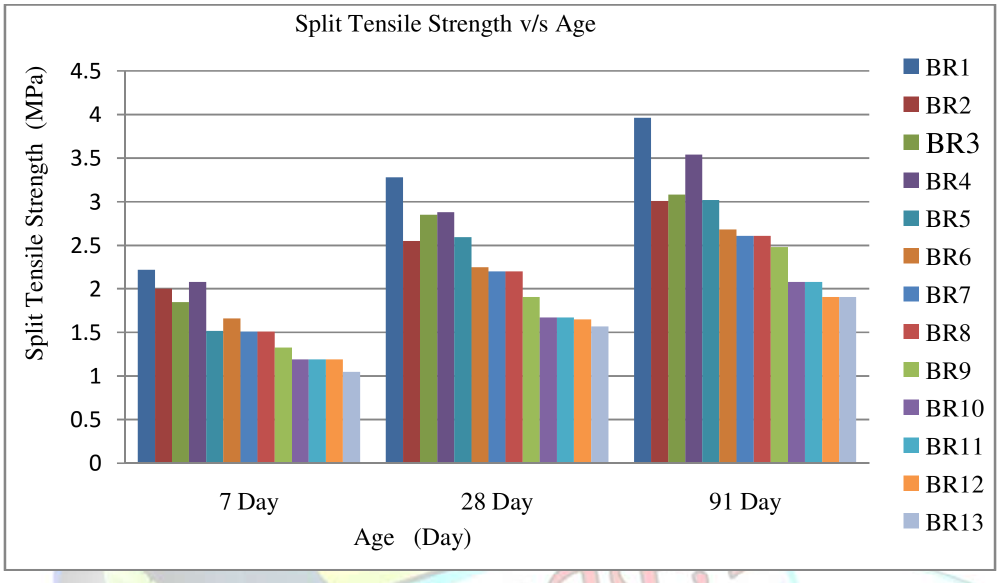

Fig. 2 Variation of Split Tensile Strength of Cylinder with Age

The split tensile strength increased with a decrease in percentage of bagasse ash and RHA. The results of split tensile strength of cylinder for 7, 28 and 91 day curing are given Table 6. Also results are compared graphically in Fig. 2 It can be seen from the Fig. 2 that the split tensile strength at 28 days curing for control mix BR1 achieved 3.28 MPa.Mixes BR2 to BR13 showed increase of 21.56 to 41.31 percent from 7 days to 28 days. Mixes BR1 to BR16 showed increase of 8.07 to 29.84 percent from 28 days to 91 day. The significant increase in strength of concrete is due to pozzolanic reaction of bagasse ash and RHA.

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3. Flexural Strength

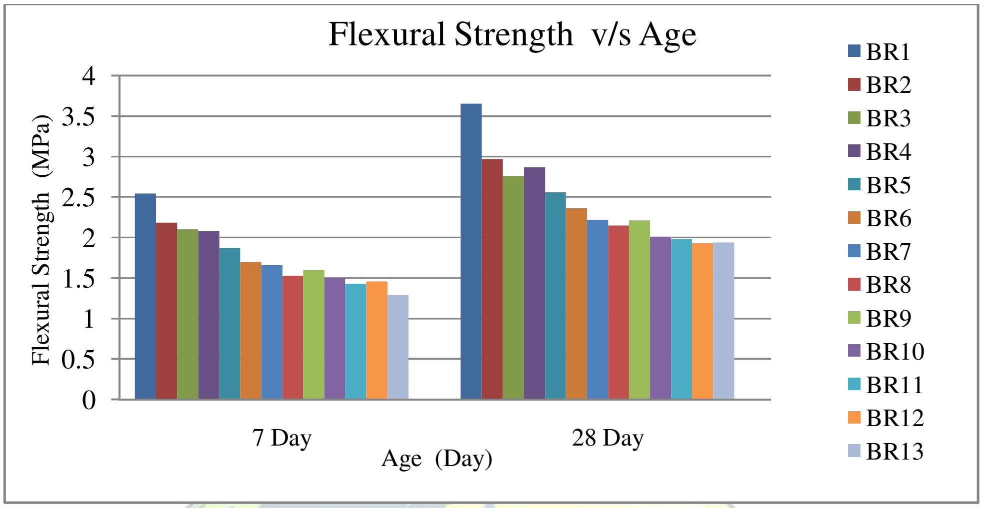

Fig. 3 Variation Of Flexural Strength of beams with Ages

The flexural strength of concrete beam were tested in the laboratory conditions at the age from 7 and 28 day and results were given in Table 6. Like compressive strength and split tensile strength results, the flexural strength of concrete mix also increased with decrease in bagasse ash and RHA percent. The results of flexural strength at 7 and 28 day curing are given in Table 6.It can be seen from the Fig. 3that the flexural strength at 28 days curing for control mix BR1 achieved 3.65 MPa. The mixes BR2 to BR16 showed increase of 24.35 to 33.50 percent from 7 to 28 day. The optimum flexural strength is achieved by BR 4 i.e. 10 percent replacement of baggase ash and RHA and QD 50 percent.

VI. CONCLUSION

- The percentage of replacement of cement by bagasse ash and RHA increases the slump flow, T50cm slump flow, J-ring, V funnel and L box decreases. The reduction in viscosity of SCC, the time required for slump flow value decreases.
- The compressive strength increased with a decrease in the percentage of the bagasse ash and RHA, but 28 days compressive strength achieved 40.92 MPa was that made with 10% partial replacement of RHA and BA to cement and 50% of quarry dust to fine aggregate when compared to other replacement for 28 day strength. The significant increase in strength bagasse ash and RHA concrete is due to pozzolanic reaction.
- The splitting tensile strength decreases as the percentage of replacement increases for all the mixes.The split tensile strength of SCC is obtained maximum for BR i.e. 10% partial replacement of RHA and BA to cement and 50% to fine aggregate.
- Like compressive strength and splitting tensile strength results, the flexural strength of concrete mixtures also increased with decreased in bagasse ash and RHA percent.

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