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An experiment on strength and capillary water absorption of concrete made with brick fine aggregate and silica fume

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ABSTRACT

Sustainable resources management and development have been at the forefront of the important issue concerning the construction industry for the past several years. Specifically, the use of sustainable building materials and reuse waste materials is gaining importance and becoming commonplace in many areas. In the present study the hardened properties like compressive strength, split tensile strength, and also durability properties like porosity, and CSAT test was carried out on bricks fine aggregate concrete. The percentage of bricks fine aggregate that partially and fully replaced by fine aggregates by weights were 0%, 10%, 20%, 30%, 40% and 50%. Experiments were conducted for both Ordinary Concrete and bricks fine aggregate Concrete with different percentages of bricks fine aggregate (BFA). It is observed from the experimental results and its analysis, that the compressive strength of concrete, splitting tensile strength of concrete increases with the addition of low Percentage of bricks fine aggregate. The results show that the optimum replacement of recycled bricks fine aggregate with fine aggregates was 20%. Up to 20% replacement, it is possible to gain the same strength as conventional concrete. Beyond 20% replacement the strength results following a decreasing trend. Moreover, capillary suction absorption increasing with increase in replacement of BFA. It was also found that the bricks fine aggregate concrete perform well up 20% replacement of BFA with fine aggregate. It was clear that firstly porosity increasing in 7 and 14 days after decreasing with a long period and minimum porosity obtained with mix 80%FA+20%BFA+10%SF.

Keywords— *Bricks fine aggregate, Silica fume admixture, Workability, Compressive strength, Split tensile strength, Durability*

1. INTRODUCTION

The present-day world is witnessing the construction of very challenging and difficult civil engineering structures. Quite often, concrete is the most important and widely used material is called upon to possess very high strength and sufficient workability properties. Efforts are being made in the field of concrete technology to develop such concretes with special characteristics. Researchers all over the world are attempting to develop high performance concretes by using bricks kiln dust in concrete up to certain proportions. A sustainable construction has become a great concern over construction practice at the expense of the future of our planet. Due to the development and modernization of cities, lots of construction activities are going on all over the world. Concrete is the most widely used construction material in the field of civil engineering, consumed rapidly by the construction industries. A study reveals that 10-12 billion ton of concrete consumes annually. Such a huge consumption of concrete requires a huge volume of naturally occurring aggregates.

2. MATERIALS USED

2.1 Cement

Ordinary Portland cement (OPC) from a single lot was used throughout the course of the investigation. The physical properties of the cement are determined from various tests, conforming to Indian Standard IS: 1489-1991(Part-1) are listed in Table 3.1. All the tests were carried out as per recommendations of IS: 4031-1988. Cement was carefully stored to prevent deterioration in its properties due to contact with the moisture.

2.2 Course aggregate

Crushed angular granite metal from a local source was used as coarse aggregate. The specific gravity was 2.67; the coarse aggregate is defined as that retained on 4.75 mm IS sieve. To increase the density of the resulting concrete mix, the coarse aggregate is frequently used in 20mm sizes.

2.3 Fine Aggregate

IS 383-1970 defines the fine aggregate, as the one passing 4.75 mm IS sieve. The fine aggregate is often termed as a sand size aggregate. Locally available riverbed sand was used in the present study. The sand conforms to grading Zone – III as per IS 383 – 1970 respectively. The specific gravity was 1.78

2.4 Bricks fine aggregate

Brick Fine Aggregate is a waste product obtained from different brick kilns and tile factories. There is numerous brick kiln which has grown over the decades in an unplanned way in different part of the country. Tons of waste products like brick dust or broken pieces or flakes of bricks (brickbat) come out from these kilns and factories. So far, such materials have been used just for filling low lying areas or are dumped as waste material. The specific gravity was 2.55. The bricks kiln dust conforms to grading Zone – III as per IS 383 – 1970 respectively.

3. RESULT AND DISCUSSION ON EXPERIMENTAL TESTS

3.1 Workability of Concrete Mixes

The workability of concrete mixes was found out by slump test as per procedure is given in chapter 3. w/b ratio was different for all the concrete mixes. The workability of concrete depends upon the water-cement ratio. The workability results of different concrete mixes were shown in table 1.

Table 1: Workability values for different concrete mixes

Mix no.	Description	Slump (mm)
1	100%FA+0%BFA+10%SF+90%OPC	115
2	90%FA+10%BFA+10%SF+90%OPC	112
3	80%FA+20%BFA+10%SF+90%OPC	101
4	70%FA+30%BFA+10%SF+90%OPC	99
5	60%FA+40%BFA+10%SF+90%OPC	95
6	50%FA+50%BFA+10%SF+90%OPC	90

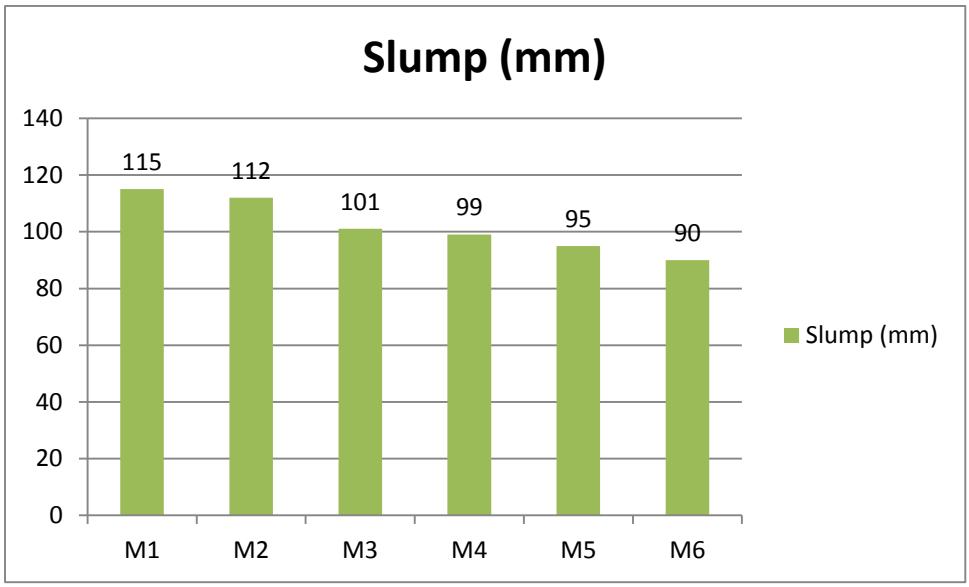

Fig. 1: Slump test results

Table 4.1 shows that as the addition of Brick Fine Aggregate to concrete mix increases, the workability of the concrete mix was found to decrease as compared to the control mix. The addition of bricks kiln dust into the concrete mix further decreases the workability.

3.2 Compressive Strength

The results of the compressive strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section

Table 2: Compressive strength (MPa) results of all mixes of concrete at different curing ages

Mix no.	Description	7 Days	14 Days	28 Days	56 Days	90 Days
1	100%FA+0%BFA+10%SF+90%OPC	18.00	21.50	35.12	38.25	39.40
2	90%FA+10%BFA+10%SF+90%OPC	17.65	20.50	35.10	37.00	38.80
3	80%FA+20%BFA+10%SF+90%OPC	17.82	21.45	34.89	37.99	37.40
4	70%FA+30%BFA+10%SF+90%OPC	16.01	21.11	32.10	36.12	37.20
5	60%FA+40%BFA+10%SF+90%OPC	16.50	19.80	28.50	32.30	36.30
6	50%FA+50%BFA+10%SF+90%OPC	15.20	17.10	24.50	28.8	34.50

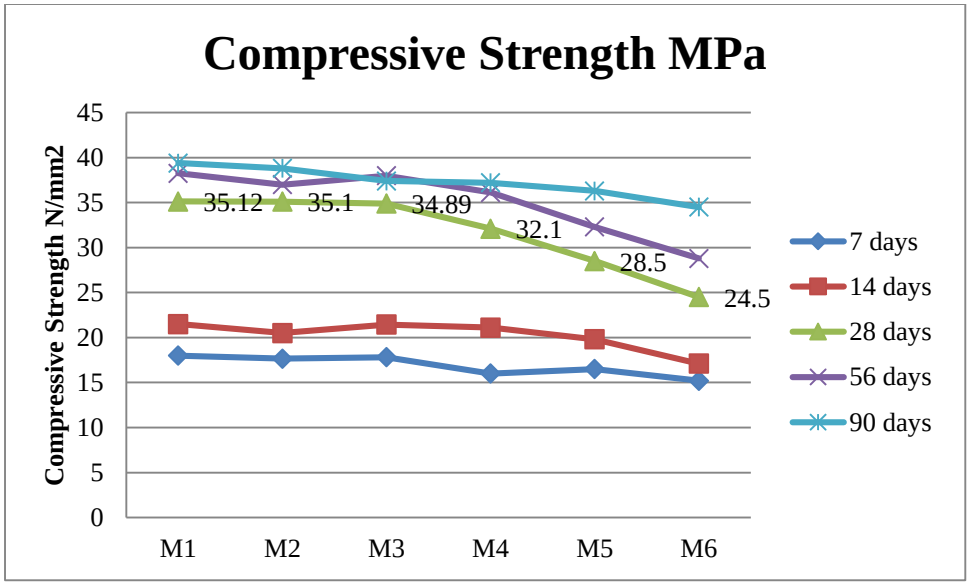

Fig. 2: Compressive strength results

Table 2 shows that addition of BFA 50% replacement by weight of fine aggregate shows a decrease in compressive strength at 28 days concrete compared with control mix of concrete. It can also be observed from Fig 4.1 that the maximum compressive strength at 28 days of curing was obtained for a mix containing 90%FA+10%BFA+10%SF+90%OPC.

3.4 Split Tensile Strength Test Results

The results of the splitting tensile strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section.

Table 3: Splitting tensile strength (MPa) results of all mixes of concrete at different curing ages

Mix no.	Description	7 Days	14 Days	28 Days	56 Days	90 Days
1	100%FA+0%BFA+10%SF+90%OPC	3.52	3.65	3.99	4.12	4.30
2	90%FA+10%BFA+10%SF+90%OPC	3.30	3.50	4.01	4.25	4.26
3	80%FA+20%BFA+10%SF+90%OPC	3.50	3.45	3.85	4.13	4.20
4	70%FA+30%BFA+10%SF+90%OPC	3.25	3.20	3.59	3.81	3.86
5	60%FA+40%BFA+10%SF+90%OPC	2.58	2.91	3.51	3.60	3.71
6	50%FA+50%BFA+10%SF+90%OPC	2.30	2.45	2.50	2.60	2.75

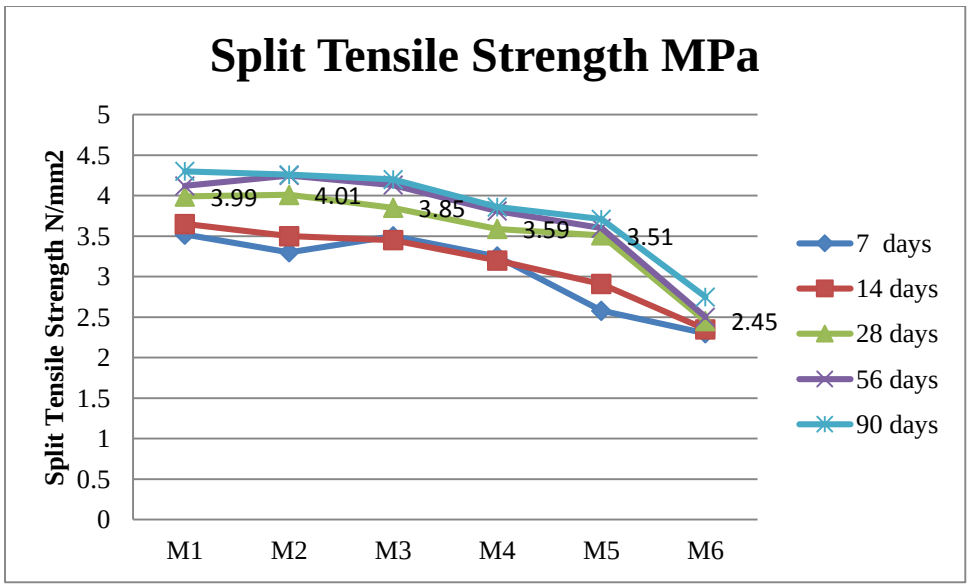

Fig. 3: Split tensile strength results

Figure 3 shows that the splitting tensile strength test results of bricks fine aggregate concrete show The maximum value of splitting tensile strength obtained for content 90%FA+10%BFA+10%SF+90%OPC mix was 4.01MPa and 4.25MPa at 28 and 90 days respectively.

4. CAPILLARY SUCTION ABSORPTION TEST RESULTS

Sorptivity is defined as the rate of movement of a waterfront through a porous material under capillary action. Sorptivity test differs from the ISAT as the former measures the rate of capillary suction as opposed to the bulk effect of capillary suction in the latter at a specified time.

Table 4: Average IRA (mm/Sec$^{1/2}$) at 56 and 90 days of curing

Mix no.	Description	Average IRA (mm/Sec$^{1/2}$)	
		56 days	90 days
1	100%FA+0%BFA+10%SF+90%OPC	0.0141	0.0130
2	90%FA+10%BFA+10%SF+90%OPC	0.0149	0.0125
3	80%FA+20%BFA+10%SF+90%OPC	0.0135	0.0121
4	70%FA+30%BFA+10%SF+90%OPC	0.0157	0.0152
5	60%FA+40%BFA+10%SF+90%OPC	0.0174	0.0189

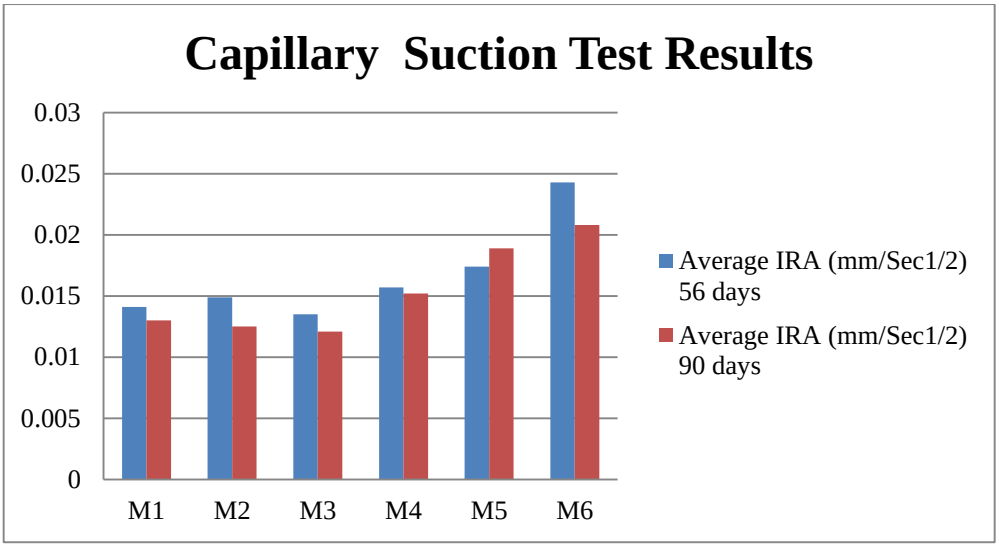

Fig. 4: Capillary suction test results

The lowest IRA value was obtained with a mix containing 80%FA+20%BFA+10%SF+90%OPC for all curing ages, whereas mix containing 50%FA+50%BFA+10%SF+90%OPC give the maximum value at all curing ages.

5. CONCLUSION

In the current investigation, bricks fine aggregate (BFA) were used to examine the strength and water absorption characteristics using Capillary Suction test as per C 1585 – 04, and porosity test. The experimental data obtained has been analyzed and discussed in Chapter-4, to fulfil to the best of ability, the objectives set forth for the present investigation.

a. Bricks fine aggregate can be efficiently used to produce good quality concrete and mortar with the satisfactory slump and setting times. The test results show that results are within the permissible limits prescribed by the IS Standards.
b. All concrete mixes using bricks fine aggregate fulfilled the performance criteria for fresh and hardened properties.
c. Under certain conditions, replacement of fine aggregate by bricks fine aggregate of appears to increase the strength of concrete.
d. Good hardened properties were achieved for the concretes with 20% bricks kiln dust which can be considered as the optimum content for high compressive strength.
e. The compressive strength of concrete increase and a similar level in containing 80%FA+20%BFA+10%SF as well as Tensile strength as compared to the control mix.
f. It was observed that maximum water absorption in mix 50%FA+50%BFA+10%SF+90%OPC and minimum water absorption up to 20% replacement of BFA.

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