EXPERIMENTAL STUDY ON STRENGTH BEHAVIOR OF CENT PERCENT ARTIFICIAL SAND CONCRETE AND THE ROLE OF SILICA FUME IN IT

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ABSTRACT

Since the food cloth and shelter are the most basic needs of mankind. Food and clothes have become cheaper whereas the shelter is becoming day by day costlier, hence affecting the poorest of the poor. The concrete is the basic ingredient for the shelter for mankind now days. Since the huge quantum of constructions is going on every where the cost and non availability of Natural River bedded sand which is the basic ingredient of concrete is touching the sky. Civil engineering scientists are bending upon investigating the substitute source to natural river bedded sand utilization as fine aggregates in concrete. With the motive of solving the burning basic problem facing by mankind the author has taken up the study with his own financial contribution. Herein after quarrying and manufacturing of coarse aggregates, the powdered form of material is thrown away; in fact it found that this powdered left out form of the material becoming dust and polluting the atmosphere at many instances. The author utilized this powdered form of the material as fine aggregates in concretes of grade M15 and M25 after performing the necessary tests on it and passing it through IS 4.75 mm sieve. The cubes of standard sizes 15cmx15cmx15cm were cast in 96 numbers in concrete material casting area of KCT Engineering College Kalburgi. After curing them for 3, 7, 21, and 28 days cubes were tested in compressive testing machine. Positive results were obtained by the author at 28 days of curing, at 8% of silica fume incorporation as a replacement to cement highest strength is achieved in the concrete, which is good enough to be substituted as structural concrete.

Keywords: *Silica fume, artificial sand, compressive strength, compressive testing machine, IS sieves.*

I. INTRODUCTION

Concrete is most widely used as manmade construction material in the world. Concrete is so closely related with every construction activity that it touches every human being in his day to day living. It is obtained by mixing cementations materials, water and aggregate and sometimes admixtures in required proportions if needed. Concrete does not solidify from drying after mixing and placement; the water reacts with the cement in a chemical process known as hydration. The mixtures when placed in forms are allowed to cure and harden into a rock like mass known as concrete. Fine aggregate is generally natural sand and is graded from particle size of 4.75mm down to 70 micron. The concrete grows stronger with age. The strength, durability and other characteristics of the concrete depend upon the properties of its ingredients, on the proportions of mix, the method of compaction and other controls during placing, compaction and curing. The supply of sand is being threatened by a number of factors on one hand while its demand is increasing at alarming rate on the other hand. Since the food cloth and shelter are the most basic needs of mankind. Food and clothes have become cheaper whereas the shelter is becoming day by day costlier, hence affecting the poorest of the poor. The concrete is the basic ingredient for the shelter for mankind now days. Since the huge quantum of constructions is going on every where the cost and non availability of Natural River bedded sand which is the basic ingredient of concrete is touching the sky. Civil engineering scientists are bending upon investigating the substitute source to natural river bedded sand utilization as fine aggregates in concrete. With the motive of solving the burning basic problem facing by mankind the author has taken up the study with his own financial contribution. Herein after quarrying and manufacturing of coarse aggregates, the powdered form of material is thrown away; in fact it found that this powdered left out form of the material becoming dust and polluting the atmosphere at many instances. The author utilized this powdered form of the material as

fine aggregates in concretes of grade M15 and M25 after performing the necessary tests on it and passing it through IS 4.75 mm sieve. The strength of concrete is affected partly by the relative proportion of cement and of the fine and coarse aggregates but the water-cement ratio is another important factor. There is an optimum amount of water that will produce a concrete of maximum strength from a particular mix of fine and coarse aggregate and cement. The ease of working with the concrete (i.e. workability) also depends on the quality of water used. The use of less than the optimum amount of water may make setting difficult and reduce workability. On the other hand, greater shrinkage and a reduction in strength will occur when more water than the optimum amount is used. Artificially prepared sand by crushing stones given the compatible strength compared to using river bedded sand[2] Recycled coarse aggregate shows higher water absorption and higher moisture content than the natural coarse aggregates[3] specimens cast with cent percent replacement of river bedded sand by M-Sand gives similar strength as that of Normal concrete[7].

II. OBJECTIVES

The following objectives are set for this study by the author

1. To study the compressive strength of normal concrete of M15 and M25 grades.
2. To study the compressive strength of concrete cast with replacement of 6% by mass cement by silica fume and 100% replacement of fine aggregates with artificial sand.
3. To study the compressive strength of concrete cast with replacement of 8% by mass cement by silica fume and 100% replacement of fine aggregates with artificial sand.
4. To study the compressive strength of concrete cast with replacement of 10% by mass cement by silica fume and 100% replacement of fine aggregates with artificial sand.
5. To ascertain from the results of compressive strength, suitability of replacement of artificial sand and by Natural River bedded sand and its usage for structural concrete,.
6. Also to study the role of silica fume, at which point of replacement to cement concrete develops highest strength.

II. METHODOLOGY AND MATERIALS

1 Methodology

After performing the basic necessary tests on materials, for reaching the above cited objectives, author decided to cast in totality 96 numbers of standard sized concrete cubes. A minimum of 3 number of cubes for each set of curing period hence total 12 number of cubes for normal concrete preparation of M15 grade named as N15, and same number for M25 grade named as N25 were cast by researcher. Author means normal concrete as it is a usual concrete prepared by using normal ingredients like cement Natural River bedded sand and normal locally available coarse aggregates in the native of researcher. Also similarly 24 numbers of cubes was cast for concrete prepared wherein silica fume is replaced in place of cement by 6% weight for M15 and M25 grade of concretes and totally replacing natural sand by artificial sand. Similarly 24 more cubes were cast keeping all other parameters of replacement same except silica fume by 8%. Likewise 24 more cubes were cast keeping all other parameters figures of replacement same except silica fume by 10%. Hence in this way in totality 24+24+24+24=94 number of cubes of sizes 15cmx15cmx15cm were cast. Curing period decided was 3,7,21 and 28 days.

Total 96 numbers of cubes were tested in material testing laboratory's Compression testing machine of KCT engineering college Gulbarga, Karnataka, India, in order to ascertain and reach the targeted objectives of study.

2 Materials

2.1 Cement

Ordinary Portland cement of 53 grade of Ultratec brand purchased from Syed Barey cement agency, Roza , Kalburgi, was used and tested as per IS: 4031 – 1988 and found to be

confirming to various Specifications as per IS: 12269 –1987m the results are tabulated in Table 1 which shows the properties of cement.

Table1: Test Results of properties of Cement

SN	Properties	Value
1	Normal consistency	30%
2	Initial Setting ti	35 Min
3	Compressive Strength (7 days)	38 N/mm^2
4	Compressive Strength (14 days)	48 N/mm^2
5	Compressive Strength (28 days)	53 N/mm^2
6	Specific Gravit	2.98

2.2. Fine aggregate

a. Artificial sand

In the present investigation, fine aggregate is artificial sand from local market is used. The properties of fine aggregate are tested and tabulated in Table 2.

Table 2: Test on Fine Aggregate (Artificial sand)

SL No.	Properties	Value
1	Specific Gravity	2.63
2	Fineness Modulus	3.160%
3	Water absorption	1.8%
4	Surface Texture	smooth
5	Bulk Density	1616kg/m^3
6	Zone	I

Fine aggregate

b. Natural River sand

Locally available river sand is used for this experimental work for casting normal concrete, and the physical properties of natural sand obtained by conducting laboratory tests are given in table 3.

Table 3: Test on Fine Aggregate (Natural River Sand)

SL No.	Properties	Value
1	Specific Gravity	2.46
2	Water absorption	3.50%
3	Moisture content	1.6%
4	Zone	II

2.3. Coarse aggregates

Locally available coarse aggregates of basalt stone retaining on 4.75mm sieve is used.

Table 4: Physical properties of Coarse Aggregate

S.NO	characteristics	Value obtained experimentally
1.	Fineness modulus	7.73
2.	Specific gravity	2.59

2.4. Silica Fume:

Silica fume as shown in Fig-1 is a byproduct resulting from reduction of high purity quartz with coal or coke and wood chips in an electric arc furnace during the production of silicon metal or Ferro silicon alloys. The specific gravity of silica fume is 2.29. It consist of 0.1 to 1 micron sized fine, smooth spherical glassy particles with fineness of 20m² /gm. This is cheaply available in market.

Fig 1: Silica fume

2.5. Water

Potable water suitable for drinking purpose available in the campus of KCT Engineering College is utilized in the preparation of concrete.

Mix Design, Slump and compaction factor tests slump test are also carried out suitably.

III. RESULTS AND DISCUSSIONS

Testing of cubes is done after de molding and completing necessary decided period of curing in Compression testing machine. The results are tabulated as follows.

Table 5: Compressive strength of various concretes in N/mm^2

Sl No	Concrete description	Compressive strength with curing age			
		3 days	7 days	21days	28days
Normal concrete (Common ingredients of concrete)					
1	N_{15}	8.49	14.12	19.32	21.68
2	N_{25}	12.54	20.10	27.54	31.60
Replace 6% silica fume and 100% artificial sand concrete					
3	M_{15}	6.52	10.59	14.32	16.10
4	M_{25}	9.96	17.30	23.30	25.78
Replace 8% silica fume and 100% artificial sand concrete					
5	M_{15}	8.12	13.11	17.98	19.78
6	M_{25}	12.35	19.82	27.79	30.57
Replace 10% silica fume and 100% artificial sand concrete					
7	M_{15}	6.20	10.35	13.89	15.76
8	M_{25}	9.69	17.09	22.66	25.24

The above tabular column number 5 which shows the compressive strength of concrete blocks of different types of concretes cast at various curing ages. If we study above tabular column it is clear that compressive strength of concrete prepared by totally replacing artificial sand is quite nearer to the compressive strength of concrete prepared by Natural River bedded sand N_{15} and N_{25} but lesser. If we go on incorporating silica fume at the place of cement used then at 6% silica fume replacement we are getting compressive strength of 16.10 N/mm^2 and 25.78 N/mm^2 for M_{15} and M_{25} grades of concrete respectively, still these values are lesser than the values of normal concrete strength. If we go on adding silica fume at the place of cement used then at 8% silica fume replacement we are getting compressive strength of 19.78 N/mm^2 and 30.57 N/mm^2 for M_{15} and M_{25} grades of concrete respectively, still these values are lesser than the values of normal concrete strength but quite nearer to the values of Normal concrete. If we go on adding silica fume at the place of cement used then at 10% silica fume replacement we are getting compressive strength of 15.76 N/mm^2 and 25.24 N/mm^2 for M_{15} and M_{25} grades of concrete respectively, these values are lesser than the values of normal concrete strength and here at this point we can notice that the strength of concrete is decreasing compared to the strength developed in the concrete at 8% replacement level, it is also evident that at this particular10% replacement level strength of concrete is falling even lesser than the strength at 6% replacement level. The maximum strength in concretes with silica fume replacement is got at 8% replacement level, which is quite nearer to the strength developed in normal concrete which is very costly because it is cast by using costly ingredient of natural river bedded sand, whereas the concrete cast by using artificial sand which is waste by product of stone crushers is available at throw able price hence this concrete is very cheaper compared to normal concrete.

IV CONCLUSION

From the above results and discussion the following conclusions to objectives set are drawn

1. Normal concrete showed the compressive strength development 21.68 N/mm^2 and 31.60 N/mm^2 at 28 days of curing for M_{15} and M_{25} Grades of concrete.

2. Whereas the compressive strength development in M_{15} and M_{25} Grades of concrete, which are cast by using 100% artificial sand and replacing cement by 6% silica fume are 16.10 N/mm^2 and 25.78 N/mm^2 respectively.
3. Whereas the compressive strength development in M_{15} and M_{25} Grades of concrete, which are cast by using 100% artificial sand and replacing cement by 8% silica fume are 19.78 N/mm^2 and 30.57 N/mm^2 respectively.
4. Whereas the compressive strength development in M_{15} and M_{25} Grades of concrete, which are cast by using 100% artificial sand and replacing cement by 10% silica fume are 15.76 N/mm^2 and 25.24N/mm^2 respectively.
5. The strength development in concrete where silica fume is replaced at 10% level and incorporation of artificial throw able priced sand for M_{15} and M_{25} Grades of concrete are19.78 N/mm^2 and 30.57 N/mm^2 respectively. Which are quite compatible and nearer to the strength results of normal concrete (which is very costly) 21.68 N/mm^2 and 31.60 N/mm^2 at 28 days of curing for M_{15} and M_{25} Grades of concrete respectively.
6. Hence author feels that concretes produced by utilization of artificial throw able priced sand and silica fume to the extent of 8% can be used comfortably for construction purpose. Also author like to state that this research work is a valuable piece, a breakthrough in the field of civil engineering and extremely beneficial to the mankind, helps in the motive of providing shelter, the balance part of food/clothe/shelter to needy people of this Globe.

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