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Review on Experimental Study of High Strength Concrete (M70) Using Manufactured Sand

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ABSTRACT
The main object of this paper is, to design mix for High strength concrete (HSC) of M70 grade concrete for various water to cement ratios using proper proportion, admixtures, and manufactured sand with required workability of concrete to adopt any shape and develop strength on hardening had made one of the most versatile materials on the earth. Concrete comprises of various ingredients which helps to develop good matrix of it. The ingredients of concrete affect its various characteristics like strength, durability etc. Fine aggregate are very vital in concrete, controls the properties of concrete. They assist in improving the cohesiveness of fresh concrete. The dredged river sand is most widely used as fine aggregate in concrete. As it exhibits good properties to the concrete, the rapid growth in construction field had leads to huge exploitation of the river sand. Now-a-days, the Government have put ban on lifting sand from River bed. Important governing factors for HSCs are strength, long term durability, serviceability as determined by crack and deflection control, as well as response to long term environmental effects. Concrete mix design of M70 grade was done according to Indian Standard code Concrete cube specimens were tested for evaluation of compressive strength. Also For design mix of HSC, the silica fume (SF) used at various percentage replacement levels i.e. 10%, 12%, and 14% respectively with cement whereas superplasticizer (SP) is used at 1%, 1.2%, and 1.4% .

Index Terms— High Strength Concrete, Manufactured Sand, M70, SilicaFume, Superplasticizer, Water to binder ratio.

1. INTRODUCTION

Concrete has been in use as a major building material ever since its inception. World over, last three-four decades have seen construction of innumerable reinforced concrete structures with compressive strength of concrete in the range of 60–100 MPa. The main cause of concern is the nonrenewable nature of natural sand and the corresponding increasing demand of construction industry, Therefore looking for an alternative to river sand has become a necessity. The cheapest and easiest alternative to natural sand is manufacturing sand by crushing rocks/stones in desired size and grade by suitable method. Sand produced by such means is known as manufactured/crusher/artificial sand. This paper presents the results of experimental investigation of fully replacement of natural sand by manufactured sand. In the present paper, the attempt is made to design mix for HSC of M70 grade concrete using proper proportion, admixtures, and manufactured sand with required workability. The main aim of the paper is to compare the compressive strength and workability of concrete of manufactured and natural sand in varying proportion of silica fume, super plasticizer, water/binder ratio. The results show that concrete with manufactured sand shows higher compressive strength whereas workability decreased with increasing proportion of manufactured sand.

2. LITERATURE REVIEW

There is a little available published data on the use of manufactured sand as a substitute to river sand. Some of the previous study or literature data is presented as below:

[1] M. Mazloom et. al. (2004) have done the experimental work on short and long term mechanical properties of HSC at different levels of silica fume. The mixes were made, having fixed water to binder ratio which is 0.35. The cement is replaced by silica fume at 0%, 6%, 10% and 15% percentage levels.From the results it was concluded that, for higher replacement of silica fume requires more dosage of superplasticizer. [2] Vinayak R. supekar and Popat D. Kumbhar (2012) studied the properties of the concrete such as workability and compressive strength of concrete. The mix designs were made by replacing river sand with artificial sand at different levels i.e. at 100%, 60%, 40%, 20% and 0%. Using these replacement levels M20 grade

concrete is prepared. The results have shown that the river sand can be replaced with artificial sand up to 60%, with reliable strength and workability properties. [3] B. Krishna Kumari Bai and M. Kanta Rao (2015) did detailed study on the effect of fly ash, SF and its combinations on strength and durability properties on HPC. Fly ash was replaced with cement by various percentages i.e., 5%, 10%, 15%, 20%, 25% and SF as addition of 10% by weight of cement for w/b ratio 0.32. For M80 grade concrete with proportion (1:0.8:1.7) several tests were performed such as compressive strength, workability, durability, flexural strength and split tensile strength etc. Also, they did study on admixtures use to reduce the cement content. The compressive strength results increased by 11% by adding 15% fly ash and 10% SF.

3. SCOPE OF THE STUDY

- River sand was used as fine aggregate in many parts of the world and thus the requirement for it is more. But continuous quarrying of river sand from river bed has led to many environmental problems.
- To solve the above problem an alternate to river sand is very much the need of the day. Manufactured sand which is a processed product of fine aggregate form various rock sources is the most suitable and economically viable option.
- To design concrete mix of grade M70 using manufactured sand. To determine experimentally, strength of concrete mix for HSC using manufactured sand. Optimize mix proportion of M70 grade concrete using manufactured sand

4. MATERIALS FOR EXPERIMENTATION WORK

4.1 .Fine Aggregate

Manufactured sand: As manufactured sand is total replacement to natural sand as fine aggregate. Specific gravity of fine aggregate is very much responsible for the strength of concrete. The specific gravity and water absorption of manufactured sand without dust is 2.23 and 6% respectively whereas manufactured sand without dust is 2.74 and 1.6% respectively. Sieve analysis giving fineness modulus 4.46 is as shown below in table 1.

Table 1: Sieve Analysis of Fine Aggregate

Sieve Size	Wt. of Sample retained (gm.)	Individual % wt. retained	Cumulative % wt. retained	% Pass-ing
4.75 mm	8	0.4	0.4	99.6
2.36 mm	224	11.15	11.55	88.45
1.18 mm	510	25.5	37.05	62.95
600µ	589	29.45	66.5	33.5
300µ	300	15	81.5	18.5
150µ	171	8.55	90.05	9.95
Pan	198	9.9	99.95	0.05

The fig.1 shows the results of sieve analysis, giving s-shape curve required for zone selection. The sample would unable to give the required properties. So for more specific gravity result,
there should be minimum silt content in the manufactured sand.

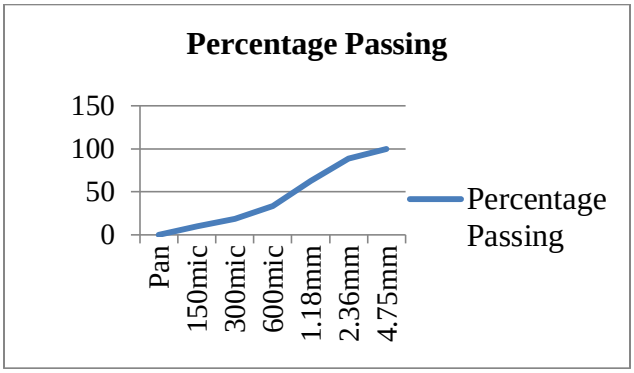

Figure1: Sieve Analysis of Fine Aggregate

4.2 Coarse aggregate

Coarse aggregate used has angular shape having maximum size 20mm. The specific gravity and water absorption was found to be 2.94 and 1.47% respectively Sieve analysis giving fineness modulus 5.67 is as shown below in table 2.

Table 2 : Physical Properties of Coarse Aggregate

Physical Properties	Average Values
Fineness modulus	5.67
Specific gravity	2.94
Water absorption (%)	1.47

4.3 Mineral Admixture

Silica fume as a mineral admixture giving specific gravity 2.21 is partially replaced with cement. In this study proportion used is 10%, 12% and 14%

respectively about cementitious material. Silica fume reacts with water forms finer paste as compare to cement paste.

4.4 Cement

In this research work Ultrarech OPC 53 grade cement is used. The most widely used cement is Portland cement. The specific gravity of cement is 3.15. Ordinary Portland cement of 53 grade conforming to IS: 12269-1987 has been used throughout the experimentation.

Physical properties of cement are given in table 3.

Table 3: Physical Properties of Cement

Properties	**Average values for OPC used in the present investigation**	**Standard values of OPC as per IS : (12269-1987)**
Specific gravity	`3.15	-
Initial setting time (min)	160	> 30
Final setting time (min)	230	< 600
Soundness (mm)	1.0	< 10
Compressive strength (MPa) 28 – days	69	> 53

4.5 Chemical Admixture

The super plasticizer used in concrete mix makes it highly workable for more time with much lesser water quantity. The BASF's MasterGlenium ACE 30JP superplasticizer having specific gravity of 1.10 was used to achieve the desired slump flow value for HSC. The superplasticizer use at three different percentage levels (i.e. 1%, 1.2% and 1.4%). The trial mixes were made of same grade to find the compatibility of superplasticizer for maximum compressive strength results. According to IS10262:2009, maximum percentage of superplasticizer is used is 2%. But trials should make from 1% superplasticizer by mass of cementitious material.

4.6 Water

Water is fit for drinking is generally considered for making concrete. Water has two functions in a concrete mix. Firstly, it reacts chemically with the cement to form a cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Secondly, it serves as a lubricant in the mixture of fine aggregates and cement

5. MIX PROPORTION AND MIX DETAILS

Concrete mix proportion is designed as per IS 10262:2009 "Concrete mix proportioning-guidelines". Amount of silica fume replaced is 10%, 12% and 14% of cementitious material and superplasticizer used is 1%, 1.2% and 1.4% of cementitious material at W/B ratio 0.30, 0.28, 0.27. First trials are made for each w/b ratio. But for w/b ratio 0.30 and 0.28 fails to give target strength for M70 grade HSC. Hence, reduction of w/b ratio to 0.27 which achieve the target strength for M70 grade HSC concrete. Amount of silica fume replaced is 10% of cementitious material and superplasticizer used is 1.2% of cementitious material.. The mix proportion for w/b ratio 0.27 is given in table 4.

Table No.4: Mix proportion for M70

Grade	M70
Water/binder ratio	0.27
Cement as binder(Kg/m^3)	584.185
Fine Aggregate (Kg/m^3)	650.958
Coarse Aggregate (Kg/m^3)	1135.73
Silica Fume (Kg/m^3)	58.42
Super plasticizer(Kg/m^3)	7.01

6. RESULTS

Compressive strength of M70 grade concrete for above proportion is found as follows.

	Duration	Compressive strength (N/mm2)
M70 grade concrete	7 days	61.68
	28 days	79.56

Limiting strength value for M70 grade concrete after 7 and 28 days should be 65% (50.86 N/mm^2) and 99% (77.46 N/mm^2) of its target mean strength respectively. It can be seen that the obtained compressive strength results of M70 grade concrete using manufactured sand are more than the limiting strength values.

7. CONCLUSION

The manufactured sand is used in natural concrete all over the world. It gives good properties. The use of manufactured sand for HSC is the present need. It is observed that concrete strength is increased up to M70 grade from above experimentation. Therefore it is effective and convenient alternative as fine aggregate. HSC concrete can be developed using manufactured sand supported that use of mineral and

chemical admixture can improve the compressive strength of concrete.

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