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EXPERIMENTAL STUDY ON SCC BY ADDING MINERAL ADMIXTURE

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ABSTRACT

The last few decades are well thought-out to be the era of the self-compacting concrete and thousands of research has been carried out. In India, the development of concrete possessing self-compacting properties is still very much in its initial stages. Over the past couple of years, few attempts were made still the cost of production of such concrete is a challenging issue for the present concrete engineers. Hence, in the present study an attempt is done to understand the effect of copper slag as a mineral admixture on the properties of self compacting concrete. Hence, our attempt is to produce more economical, durable and sustainable SCC using mineral admixture. In the present study copper slag is that by product which is used in replacement with sand without disturbing properties of concrete with respect to strength, workability, and other mechanical properties.

KEYWORDS: Self compacting concrete, Admixture, Copper slag, Durability, Strength

I. INTRODUCTION

Now a day major problems faced by civil engineers is construct durable concrete structure. For making durable concrete structures, proper and sufficient compaction is necessary. For normal or conventional concrete compaction is done by vibrators. In case of highly congested reinforcement, it is very difficult to compact the concrete and if over vibration is done then it causes segregation in concrete. For such structure, concrete which can easily flow is required. Self Compacting Concrete (SCC) is the concrete which settles and get compacted by its own weight. SCC was proposed by Okamura in 1986 for Japan. Later on lots of researchers are working on flowability, strength and durability performance of the concrete.

SCC is the concrete which meets the special performance and uniformity requirements which cannot be always obtained by conventional concrete, normal mixing and curing practices. SCC consists of different engineered materials like cement, sand, aggregate, admixtures. Chemical admixtures were used for care of specific requirements such as strength, high workability, less permeability, high flow ability, durability, resistance to stresses, and resistance to segregation.

Copper slag is a by-product obtained during the production of copper metal, which can be used as pozzolana in the production of cementing materials. The raw copper slag had particle sizes ranging from micrometers to larger than 1 cm in diameter. Industrial sludge is generated at a rate of 100 metric tons/day, from a copper slag recycling plant. An attempt is made to produce more economical and durable concrete using industrial by-products i.e. copper slag. Technically copper slag is used to improve the strength and the durability of concrete. Hence, aim of our project is to check the behavior of conventional concrete under the influence of copper slag which is normally available in market now days. The effect of copper slag on conventional concrete and SCC were studied.

II. OBJECTIVES

- To evaluate the interaction and complex behavior between the admixture and cement by replacing the cement content.
- To optimize the percentage of copper slag to be used for SCC.
- To compare fresh mechanical properties of SCC with copper slag.

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III. METHODOLOGY AND MATERIALS

For a present study copper slag is selected as a partial replacement of sand for both conventional concrete and self compacting concrete. All the materials which have been used in SCC are tested as per Indian standards. Tests for fresh concrete like slump flow, j-ring, u-box, were carried out to check workability of SCC with the selected proportion. Cubes were casted for conventional concrete and concrete with copper slag replacement with fine aggregate of 10%, 20%, 30%. All specimens were demoulded after 24 hours and kept under curing tank and tested after 7 days, 14 days 28 days and 60 days. Table no. 1 shows the cubes detail which were casted.

Table 1: casted cubes detail

Replacement of Sand	3 days	7 days	28 days	60 days
Normal concrete	3 nos.	3 nos.	3 nos.	3 nos.
10% replacement by copper slag	3 nos.	3 nos.	3 nos.	3 nos.
20% replacement by copper slag	3 nos.	3 nos.	3 nos.	3 nos.
30% replacement by copper slag	3 nos.	3 nos	3 nos.	3 nos

Cement, sand, aggregates are being used in execution of research work and results are tabulated.

Cement: In this study, OPC ultratake 53 grade cement is used with following characteristics.

Table 2: Test results of cement

Item No.	Test Name	Test Result	Test Method
1	Consistency	29.5 %	I.S. 4031
2	Initial Setting time	115 min	
3	Final Setting time	260 min	
4	Soundness	1 mm	
5	Fineness	305 2/kg	

Fine aggregate: In present study as fine aggregate river sand passes through 4.75 mm IS sieve is used. Following are the results obtain from river sand.

Table: 3 Test results of fine aggregate

Item No.	Test Name	Test Result	Test Method
1	% Passing on 75 mic Silt Content	0.96%	I.S. 2386

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2	Water Absorption	0.51 %	
3	Specific Gravity	2.62	
4	Finess Modulus	2.95	

Course Aggregate: course aggregates are collected from nearby quarry retained on 4.75 mm IS sieve. Following table shows the test results.

Table: 4 Test result of course aggregate

Item No.	Test Name	Test Result	Test Method
1	Water Absorption	1.04 %	I.S. 2386
2	Specific Gravity	2.84	

Copper Slag: Copper slag is collected from Bharuch GIDC passes through 4.75 mm IS sieve is used. Following are the results of copper slag.

Table: 5 Test results of Copper slag

Item No.	Test Name	Test Result	Test Method
1	Water Absorption	0.40 %	I.S. 2386
2	Specific Gravity	3.68	
3	Fineness Modulus	3.38	

Super Plasticizer (Admixture): Fosroc Brocrete named admixture is used in present study. Specific Gravity of Admixture is 1.09, solid content 33.5%, pH 6.5. This admixture was sourced from Fairmate chemicals pvt. Ltd.

Concrete: Indicative typical ranges of proportions and quantities in order to obtain self-compactability are given below.

- Water/powder ratio by volume of 0.80 to 1.10
- Total powder content - 160 to 240 litres (400-600 kg) per cubic meter.
  Coarse aggregate content normally 28 to 35 per cent by volume of the mix.
- Water/cement ratio is selected based on requirements in EN 206. Typically water content does not exceed 200 litre/m^3.
  The sand content balances the volume of the other constituents

IV. RESULTS AND DISCUSSION

To produce self compacting concrete mix design trial and error method is used. After number of trials following results are obtained as final results for controlled and SCC mix for M 30 grade concrete.

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Table: 6 mix proportions for controlled concrete and copper slag

Proportion	*Water*	*Cement*	*Sand*	*Copper slag*	*Coarse Aggregate*	*Chemical Admixture*
By Weight kg/m^3	178.0	425.0	1035.0	00 kg/bag	800.0	4.3 kg/ bag
Weight	(W/C) 0.42	1	2.44	-	1.88	-
Volume	(W/C) 0.42	1	2.24	-	1.96	-
For 1 Bag of Cement, Quantities of Materials are:						
By Weight (controlled mix)	20.9 lit/bag	50.0 kg/bag	122 kg/bag	00 kg/bag	94.1 kg/bag	500 gm/bag
By Weight (10%copper slag)	20.9 lit/bag	50.0 kg/bag	110 kg/bag	12.2 kg/bag	94.1 kg/bag	500 gm/bag
By Weight (20%copper slag)	20.9 lit/bag	50.0 kg/bag	97 kg/bag	24.4 kg/bag	94.1 kg/bag	500 gm/bag
By Weight (30%copper slag)	20.9 lit/bag	50.0 kg/bag	85 kg/bag	36.5 kg/bag	94.1 kg/bag	500 gm/bag

In SCC workability of concrete is most important factor as it has to flow by its own weight, so to check workability various tests like slum flow, V funnel, L box and U box test were conducted and following table shows the result of same.

Table: 7 workability test results

Sr. No.	Method/ Tests	Requirement	Controlled	10% copper slag	20% copper slag	30% copper slag
1.	Slump Flow by Abrams cone(mm)	650 - 800	750	720	700	650
2.	T-50cm Slump flow (sec)	2 - 5	3	3	4	5
3.	V Funnel (sec)	6 - 12	8	7	9	8
4.	Time increase, V-	+ 3	7	5	7	7

	funnel at T-5 min					
5.	L box (mm)	0.8 – 1.0	0.82	0.84	0.89	0.85
6.	U Box (mm)	Max. 30	12	15	18	20

1. **Slump flow:** The requirement for slump flow for SCC is in range of 650-800 mm. From table we can see that the flow content 0%, 10%, 20%, 30%, copper slag have slump flow within this range. Also as copper slag content increases, slump flow decreases.
2. **T-50cm Slump flow (sec):** The result shows that the T50 are in range of 2-5 seconds.
3. **V funnel(sec):** The range for V funnel test is 5-12 seconds. V funnel test gives an idea about the filling ability of SCC.
4. **L box (mm):** The criteria of L box are within 0.8 -1.0 mm. L box test of partial replacement with copper slag is within the EFNARK range.
5. **U box (mm) :** U box test results are under the given criteria.

Compressive strength of SCC for controlled mix and 10%, 20%, 30% replacement of fine aggregate is checked after 7 days, 14 days, 28 days and 60 days curing period. Following figure shows the results.

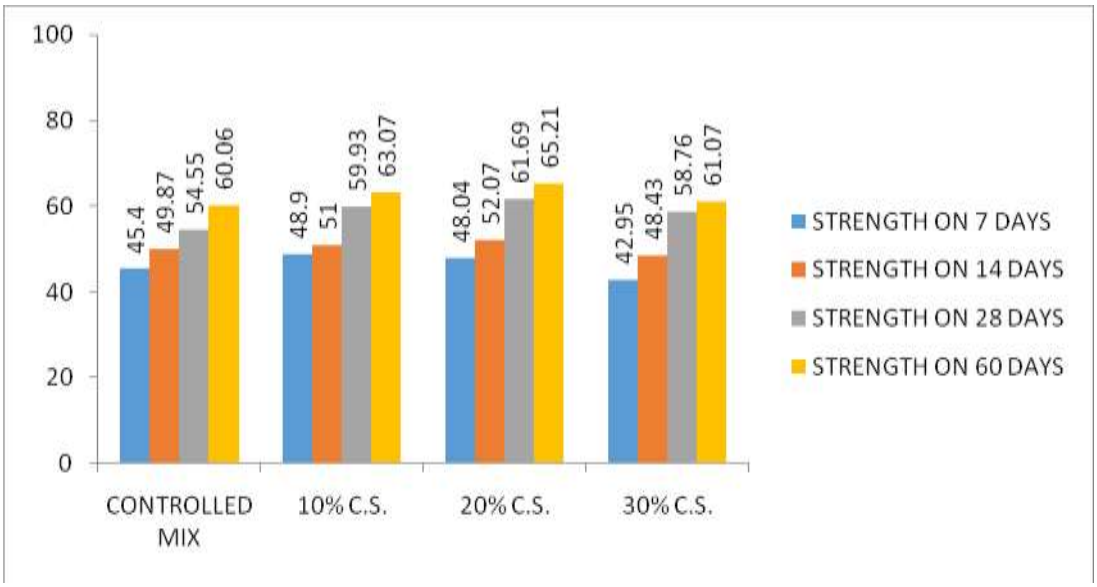

Figure 1: Compressive strength results

Compressive strength increases from 28 days to 60 days for all copper slag content. As copper slag content increases, strength for first three mixes increasing but in last mix it start to decreases. Obtain strength of 30 % replacement of copper slag is lesser than controlled mix.

V. CONCLUSION

Establishment of standard mix design procedure and appropriate testing methods is essential for widespread use of SCC. Most of Indian researchers have followed European guidelines for testing SCC. Other countries are adopting these guidelines with slight modifications as per their local conditions.

Flow ability of mortar is directly influenced by the composition of the concrete. Especially sand content influences the flow spread by affecting the free water in mortar mixer.

By using copper slag the reuse of the industrial by-product will be beneficial for environment. And replacing it with sand will also prevent the reduction in mean sea level as the river sand is replaced.

By replacing copper slag in the self compacting concrete the required strength of concrete is meeting up to 30% replacement as per results.

Further replacement of copper slag for other grade of concrete can be carried out for improving strength of concrete and making product with utilization of industrial by-product.

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