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STUDY THE EFFECT OF ALCCOFINE ON DEVELOPMENT OF HIGH STRENGTH CONCRETE

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ABSTRACT

Enhancing the concrete strength is continuously one of the chief desires of concrete technology. During the past few years, high-strength concrete (HSC) has been generating increased interest amongst civil and structural engineers. The expanding commercial use of this relatively new construction material can be explained partially by the life cycle cost-performance ratio it offers, as well as its outstanding engineering properties, such as higher compressive and tensile strengths, higher stiffness and better durability, when compared to the conventional normal strength concrete (NSC). From a historical point of view, in the middle of the 20th century concrete with characteristic strength of 25MPa was considered high-strength.

I. INTRODUCTION

In the 1980s, 50MPa concrete was considered high-strength. Nowadays, technology for producing HSC has sufficiently advanced such that concretes with compressive strengths of up to about 120MPa are commercially available, and strengths much higher than that can be produced in the laboratories. IS 456:2000 defines high-strength concrete as concrete with a compressive strength greater than 55 MPa.Production of HSC may or may not require special materials, but it definitely requires materials of highest quality and their optimum proportions. Production of HSC may or may not require special materials, but it definitely requires materials of highest quality and their optimum proportions. The production of HSC that consistently meets requirements for workability and strength development places more stringent requirements on material selection than that for lower strength concrete. It would be difficult to produce high-strength concrete mixtures without using chemical admixtures.

A common practice is to use a super plasticizer in combination with a water-reducing retarder. The basic strength to water/cement ratio relationships used for producing normal strength concrete are equally valid when applied to HSC, except that the target water/cement ratio can be in the range 0.30-0.35 or even lower. It is essential to ensure full compaction at these levels. A higher ultimate strength can be obtained by designing a mix with a low initial strength gain and cementitious additions. This is partially due to avoidance of micro-cracking associated with high thermal gradients. This effect can be facilitated if strength compliance is measured at 56 instead of 28days.

With the advancement in concrete technology, high strength and high-performance concrete is gaining popularity worldwide in the construction industry day by day. Practically high strength concrete is generally characterized by high cement contents and very low water cementitious ratio. This type of concrete suffers from two major weaknesses. It is difficult to achieve proper workability, and to retain the workability for sufficiently long time with such concrete mixes. To obtain proper workability for sufficiently long-time period it becomes necessary to use high dosage of high range water reducing agents (HRWR) and resulting cohesive and sticky mixes are equally difficult to place and compact fully and effectively. It requires a critical limit for the water content below which high HRWR dosage become not only essential but undesirable, and becomes harmful from durability point of view. Silica Fume is generally proposed against HRWR where high strength, low permeability are of prime requirements. But silica fume is often negated by the increased water and / or admixture dosage for workability of the fresh concrete.

II. ALCCOFINE

Alccofine is a new generation, micro fine material of particle size much finer than other hydraulic materials like cement, fly ash etc. manufactured in India. It has unique characteristics to enhance 'performance of concrete' in fresh and hardened stages. It can be used as practical substitute for Silica Fume as per the results obtained by Counto Micro fine products Pvt. Ltd.

Table: 1.1 Types of Alccofine

Alccofine	SCM Alccofine-1203	Low calcium Silicate
	Grouting Alccofine-1101	High calcium Silicate

It is manufactured in the controlled conditions with special equipments to produce optimized particle size distribution which is its unique property. Alccofine 1203 and Alccofine 1101 are two types with low calcium silicate and high calcium silicate respectively.

III. LITERATURE REVIEW

M. Nade and A.D. Pofale (2012); studied the partial replacement of the natural fine aggregate with granular waste slag which is a waste industrial by-product found during the production of iron or steel and utilized in cement mortar applications as an new construction material.

P J Patel et al (2013); studied experimentally the effect on Compressive and Flexural Strength of High Performance Concrete developed by using Alccofine and Fly ash.The conclusions drawn from the practical experiments conducted during the study shows that In all mix proportions prepared during the study found that the strength gain up to 7 days is excellent, between 7 to 28 days strength gain is comparatively less as compare to the strength gain at 7 days, but again between 28 to 56 days strength gain is high because of presence of mineral admixture as fly ash. The Compressive strength at 28 days is 1 to 10 % less than accepted Compressive strength as per Table-2, clause 6.2.1 of IS 456-2000.

S Seuthar et al (2013); investigated the effect of Alccofine& Fly ash on the Mechanical properties of High Performance Concrete. Cementitious blends of Portland cement, fly ash, and alccofine offer significant advantages over binary blends prepared for the experiment and even more increase over plain Portland cement. The alccofine used as mineral admixture is found to be improving the early age performance of the concrete mix prepared with the use fly ash as continuously found improving the properties of the hardened concrete as it keeps on maturing. The unique combination of alccofine and fly ash of class F is complementary for the mix, as the alccofinewill improve the early age performance of concrete and the fly ash continuously refining the properties of the hardened state concrete as it matures. As per durability aspect, such blends of alccofine and fly ash are vastly superior to plain Portland cement concrete (PPC). In many cases it is found that the price differences between the individual components may allow the ternary blend to compete with Portland cement directly on the basis of material costs.

YPatelet al(2013); studied the durability aspect of high performance concrete with alccofine and fly ash. In this study, the effect Alccofine as supplementary cementitiousmaterials and also as a filling material on the strength and durability of concretes was investigated. The conclusions drawn from the practical experiments conducted during the study shows that the investigator concluded that compressive strength achieved by using 8 % of Alccofine and 20% Fly Ash is 54.89Mpa and 72.97 MPa at 28 and 56 days respectively.

PNayak S et al(2014); investigated the Hardened Properties of Concretes developed with Micro Silica and Alccofine1203. To achieve the result Performance Optimization technique was adopted for Comparative Study.The conclusions drawn from the practical experiments conducted during the study shows thatCompressive strengths obtained from alccofine are better than micro silica if added at the same level of concretes. It was found the Compressive strength increases with addition of micro silica and alccofine up to 13.36% addition level/replacement level and then found to be starts decreasing.

IV. LITERATURE GAP

After going through the various research carried out above, the following gaps have been identified:

1. The effect of ALCCOFINE on the workability, water–cement ratio and strength properties of foundry slag concrete has not been studied.
2. The effect of ALCCOFINE on the durability properties of foundry slag concrete has not been studied.
3. None of the investigator have studied the effect of Alccofine on the partial replacement of foundry sand with fine aggregates.
4. The investigator have prepared mix design upto 70 Mpa using Alccofine or lower.
5. None of the investigators developed mathematical model based on various parameters to ascertain its strength characteristics in respect of concrete.
6. None of the investigator have studied the effect of Alccofine by using UPV and Rebound hammer.
7. None of the investigators studied environmental problems created by foundry slag wastes in the absence of proper utilization and recycling.
8. The investigators have taken the %age of Alccofineupto 10%.

V. PROBLEM STATEMENT

The problem "***Study the Effect of Alccofine on Development of High Strength Concrete***" selected for the purpose of this study may be stated as:

Research will be carried outto develop high strength foundry slag concrete using Alccofine to study different strength properties of M80 concrete samples made with various combinations of foundry slag and Alccofine.

VI. OBJECTIVES OF STUDY

Main objectives of this study are listed below:

1. To develop concrete mix of M80 grade of concrete by using different % age of alccofine and partial replacement of fine aggregate with foundry slag.
2. To find the optimum %age of alccofine in developing concrete mix.
3. To develop correlation for prediction of compressive strength of foundry slag concrete with UPV and rebound hammer values

VII. SCOPE OF STUDY

In this study, concrete of M80 grade is considered for a W/C ratio of 0.27 respectively with the targeted slump of 170 mm for the replacement of 10%, 20%, 30% of aggregates (fine) with that of slag aggregate and adding of 3%, 6%, 9%, 12%, of Alccofine. Thisconcrete mixed is studied for the properties like compressive, split tensile and flexure strengths. Also, these strength properties are compared with ultrasonic pulse velocity and rebound hammer tests.

VIII. ZMIX PROPORTIONS

Table: 1.2- Mix Proportions

Material	Control mix				
	0% Alccofine (M0) Kg/m^3	3% Alccofine (M1) Kg/m^3	6% Alccofine (M2) Kg/m^3	9% Alccofine (M3) Kg/m^3	12% Alccofine (M4) Kg/m^3
Cement PPC	440	440	440	440	440
Alccofine1203	0	13.20	26.40	39.60	52.8
W/C ratio	0.30	0.30	0.30	0.30	0.30
Water content	132	132	132	132	132

Mass of 10mm coarse aggregate	413	413	413	413	413
Mass of 20mm coarse aggregate	674	674	674	674	674
Mass of slag (0%)	0	0	0	0	0
Mass of fine aggregate	724	724	724	724	724
Mass of slag (5%)	36.2	36.2	36.2	36.2	36.2
Mass of fine aggregate	687.8	687.8	687.8	687.8	687.8
Mass of slag 10%	72.4	72.4	72.4	72.4	72.4
Mass of fine aggregate	651.6	651.6	651.6	651.6	651.6
Mass of slag 15%	108.6	108.6	108.6	108.6	108.6
Mass of fine aggregate	615.4	615.4	615.4	615.4	615.4
Super plasticizer@1.4%	6.16	6.16	6.16	6.16	6.16

IX. RESULT & DISCUSSION

Table: 1.3:Compressive strength of concrete mixes of specimen size 150 × 150 × 150

%age of Alccofine		0	3	6	9	12
0% slag	7 days	59.04	59.38	60.58	63.48	65.12
	28 days	63.46	64.29	66.22	68.15	69.23
	90 days	65.21	65.93	67.32	69.9	71.2
5% slag	7 days	60.22	61.45	64.39	69.2	74.9
	28 days	65.39	67.65	69.32	76.11	80.21
	90 days	68.11	69.44	70.86	78.24	81.39
10% slag	7 days	61.35	63.66	66.48	71.34	76.6
	28 days	65.46	68.3	69.74	77.98	81.49
	90 days	69.91	69.33	71.32	79.18	82.22
15% slag	7 days	63.49	65.95	69.26	73.15	80.4
	28 days	65.9	70.44	70.22	79.31	83.64
	90 days	70.31	71.66	72.51	80.38	85.29

Table: 1.4:Splitting Tensile Strength of Concrete Mixes with Iron Slag

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%age of Alccofine		0	3	6	9	12
0% slag	7 days	3.04	3.38	3.58	3.78	4.12
	28 days	3.46	3.69	3.82	3.95	4.23
	90 days	4.21	4.43	4.62	4.7	4.81
5% slag	7 days	3.22	3.45	3.67	3.8	4.19
	28 days	3.69	3.75	3.82	4.11	4.21
	90 days	4.42	4.44	4.86	4.94	4.97
10% slag	7 days	3.35	3.66	3.78	4.04	4.6
	28 days	3.86	3.95	4.09	4.34	4.49
	90 days	3.91	4.03	4.32	4.58	5.05
15% slag	7 days	3.49	3.95	4.26	4.65	5.3
	28 days	3.9	4.14	4.52	4.91	5.64
	90 days	3.97	4.36	4.64	5.18	5.89

Table: 1.5:Flexural Strength (MPa)

%age of Alccofine		0	3	6	9	12
0% slag	7 days	5.14	5.42	5.56	5.74	6.14
	28 days	5.42	5.63	5.84	5.98	6.2
	90 days	6.26	6.4	6.65	6.73	6.84
5% slag	7 days	5.21	5.49	5.65	5.83	6.34
	28 days	5.67	5.73	5.88	6.16	6.39
	90 days	6.45	6.53	6.89	6.96	6.99
10% slag	7 days	5.32	5.69	5.77	6.09	6.66
	28 days	5.79	5.91	6.19	6.38	6.79
	90 days	5.91	6.03	6.32	6.58	6.85
15% slag	7 days	6.59	6.99	7.28	7.63	7.76
	28 days	6.91	7.19	7.54	7.96	8.09
	90 days	6.97	7.46	7.84	8.38	8.89

X. CONCLUSION

1) From the above discussion it can be observed that with the increase in the percentage of Alccofine and Foundry Slag the compressive strength, split tensile strength, flexural strength and the UPV of the concrete mix also increases.
2) For the compressive strength, maximum percentage increased for the variation of 0, 3, 6, 9 and 12 % of Alccofine and 0, 5, 10 and 15 % of Foundry slag for 7, 28, 90 days is 26.63, 26.92 and 21.30 % respectively.
3) For the split tensile strength, maximum percentage increased for the variation of 0, 3, 6, 9 and 12 % of Alccofine and 0, 5, 10 and 15 % of Foundry slag for 7, 28, 90 days is 51.86, 44.61 and 48.36 % respectively.
4) For the flexural strength, maximum percentage increased for the variation of 0, 3, 6, 9 and 12 % of Alccofine and 0, 5, 10 and 15 % of Foundry slag for 7, 28, 90 days is 25.18, 17.17, and 27.54 % respectively.
5) This increase in the strength is due to the packing effect of alccofine because it has a optimum size particle distribution that helps to fill the gap between the particles of cement and SCM. So Alccofine is having an optimum size i.e not to coarser, not to fine either.
6) Foundry slag also contributes in the increase of the strength due to angular shape and having high toughness due to this it does not break suddenly as it shows some sign before breaking. So, this can be used in seismic zone.

XI. OUTCOMES

The following outcomes come out from this study:

1) Compressive strength, Split tensile strength and flexural strength increases with the increase in replacement levels of foundry slag up to certain limit.
2) The percentage increase in strength is grade specific i.e. for higher grades of concrete higher percentage of foundry slag can be added for replacement.
3) With the increase in percentage of foundry slag the density of concrete decreases irrespective of grade of concrete. As the specific gravity of blended slag is less, so lesser weight of fine aggregate is required which result in reduction in density of concrete.

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