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Design Mix of Concrete Grade M-60 With Alccofine

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Abstract — ***Popularity of*** *Supplementary cementeous materials (SCM) are blooming in the construction industry worldwide as these materials are bringing technical revolution in the field of civil engineering. Alccofine is a new generation micro fine concrete material for high Strength Concrete which is important in respect of workability as well as strength. The aim of this paper is to highlight the importance of Alccofine as Supplementary cementious materials in construction industries. This can be used as a SCM due to its ultrafine size and high content of calcium oxide (Cao), Alccofine1203 is essential in terms of reducing heat of hydration and strength at all stages.*

Keywords*-Alccofine, Ordinary Portland Cement, High Performance Concrete, Compressive Strength, Fly Ash*

I. INTRODUCTION

High performance concrete is a concrete mixture, which possess high durability and high strength when compared to conventional concrete. Thisconcrete contains one or more of cementious materials such as fly ash, Silica fume or ground granulated blast furnace slag and usually a super plasticizer.

High strength and high performance concrete are gaining popularity. Practically high strength concrete is generally said to be high strength concrete having high cement content and very low water cement ratio. The concrete prepared in such a manner suffer from majorly two type of weaknesses. Firstly, it is difficult to achieve workability and secondly to retain the workability for sufficiently long time with such concrete mixes. To overcome these weaknesses, it becomes necessary to use high dosage of high range water reducing agents (HRWR) i.e admixture.

Alccofine is a new generation, micro fine material of particle size much finer than other hydraulic materials like cement, fly ash, silica etc. being manufactured in India. Alccofine has unique characteristics to enhance 'performance of concrete' in fresh and hardened stages due to its optimized particle size distribution. It can be used as practical substitute for Silica Fume as it has optimum particle size distribution not too coarse, not too finer either per the results obtained by Counto Microfine products Pvt. Ltd (A joint venture with ambuja cement ltd and alcon developers). It is manufactured in the controlled conditions with special equipments to produce optimized particle size distribution which is its unique property.

Alccofine SCM-Alccofine-1203is possessing Low Calcium Silicate.

Table 1. Physical parameters of Alccofine 1203

Specific gravity	Bulk Density (kg/m3)	Partical size distribution (µ)		
2.9	600-700	d 10	d 50	d90
		1-2	4-5	8-9

Table 2. Chemical parameters of Alccofine 1203

CaO	Al2o3	SIO2	Glass content
31-33 %	23-25 %	33-35 %	>90%

Alccofine 1203 is slag based SCM having ultra fineness with optimized particle size distribution The performance of Alcofine is superior to all the other admixtures used in India. Due to high Calcium oxide (Cao) content. In the concrete mix design of Alccofine 1203 the initial rate of strength is found similar or increased to that of Silica Fume as it trigger the primary reaction during hydration and Alccofine also consumes by product calcium hydroxide from the hydration of cement to from additional C-S-H gel which similar to pozzolans. The computed blain value based on particle size distribution (PSD) is approximately 12000cm2/gm and is truly ultra fine. Due to its ultra fineness, of Alccofine 1203,it provides reduced water demand for a given workability, even up to 70% replacement level as per requirement.

Applications of Alccofine 1203 concludes • Bridges • Roads and air ports • High rise buildings

Benefits of Alccofine 1203- In Fresh State • The workability of the mix retention is improved. • Flow ability of the mix is increased • Reduction in segregation can be observed in the mix • Reduction in heat of hydration of the mix

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Benefits of Alccofine 1203 -In Hardened state • Improvement in durability of the mix • Resistance to AAR is increased • Strength at all ages is increased • Resistance to chemical attack / corrosion is improved as ingression becomes difficult • Lowers permeability of the mix

Recent application of Alccofine in India:
- Project first cable stayed bridge at Nagpur
- Kochi metro in Kerala Alccofine 1203 is being used.

1.1 Objective

The objective of this testing program is to arrive at optimum alccofine content and optimum proportions of various ingredients of concrete mix.

The concrete is proposed to designed for following requirements,
Flow – 500 mm at 3 Hours
Compressive Strength > 74 Mpa
RCPT < 1000 Coulombs
Water Permeability < 12 mm

The material for the mix includes OPC 53 grade Cement, Fly ash, Alccofine, 20 mm & 10 mm as coarse aggregate and crushed sand as fine aggregate.
Test is Performed for Design mix for Concrete compressive strength
Method of Design used : IS-10262-2009

II. EXPERIMENTAL PROGRAM

For determining the effect of ALCCOFINE 1203 on the workability, water requirement and HRWR dosages, three trials of concrete mixes were prepared, based on the following mix design methodology

A. Workability: Considering the water/binder ratio, admixture dosage constant and determining the slump and compressive strength.
B. Water Demand: Considering the admixture quantity constant and varying the water/binder ratio and determining the slump and compressive strength.
C. Admixture Requirement: Considering the water/binder ratio constant and varying the admixture content and determining slump and compressive strength.

2.1 Material

2.1.1 Sieve Analysis:

Sieve Analysis was done as per IS:383-2013

Table 3. Sieve analysis

Sieve Size (mm)	Percent Retained		
	20 mm	10 mm	Crushed sand
40	0.00	0.00	0.00
20	3.36	0.00	0.00
10	91.15	2.74	0.00
4.75	99.72	86.94	2.71
2.36	100.00	99.28	14.85
1.18	100.00	100.00	33.80
0.6	99.32	100.00	60.62
0.3	99.68	100.00	81.38
0.15	100.00	100.00	91.25
Fineness Modulus of Sand			2.84

2.1.2 Aggregate:

Fine aggregate Confirming to Grading Zone-II Table -9 of IS-383-2016. Coarse aggregate sample conforms to the requirement of single size aggregate as per IS: 383-2016.

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Table 4. Physical Properties of Coarse and Fine aggregates :

No.	Properties	20 mm	10 mm	Crushed sand
a.	Specific Gravity (SSD CONDITION)	2.91	2.91	2.87
b.	Water Absorption (%)	1.44	1.51	2.62
c.	Surface Moisture (%)	--	--	--
d.	DLBD (kg/liter)	1.55	1.53	1.72
e.	Impact value (%)	9.8	12.3	--
f.	Material finer than *75mic. (%)*	--	--	10.80

2.1.3 Cement

Table 5. Tests on Cement

No.	*Properties*	*Result*
a.	*Consistency (%)*	*28*
b.	*Specific Gravity*	*3.15*
c.	*Initial Setting time (Min.)*	*130*
d.	*Final Setting time (Min.)*	*180*
e.	*Fineness by blaine's (m^2 / kg)*	*330*
f.	*Soundness by Le-Chatelier's (mm)*	*1*
g.	*Soundness by Autoclave (%)*	*0.02*
h.	*3 Days Avg. Compressive Strength (Mpa)*	*32.9*
i.	*7 Days Avg. Compressive Strength (Mpa)*	*43.3*
j.	*28 Days Avg. Compressive Strength (Mpa)*	*>53.0*

2.1.4 Fly Ash:

Table 6. Tests on Flyash

Sl.No.	Properties	Results
a.	Specific Gravity	2.16
b.	45 µ Retained (Wet sieving) (%)	15.2
c.	Fineness by blaine's (m^2/ kg)	430
d.	Soundness by Autoclave (%)	0.008
e.	28 Days Compressive Strength with Flyash (Mpa)	35.6
f.	Control Mix 28 Days Compressive Strength (Mpa)	40.5
g.	Comparative Compressive Strength (28 Days) (%)	88.0

2.1.5 Alccofine:
Alccofine 1203 is used.

Table 7. Tests on Alccofine:

Sl.No.	Properties	Results
a.	45 µ Retained (Wet sieving) (%)	0.03
b.	Specific Gravity	2.84
c.	7 Days Compressive Strength with alccofine (Mpa)	34.0
d.	Control Mix 7 Days Compressive Strength (Mpa)	30.7
e.	Comparative Compressive Strength (7 Days) (%)	111

2.1.6 CAC Hyperfliud plus G:

Table 8. Tests on Admixture: CAC Hyperfliud plus G

Sl.No.	Properties	Result	Remark
a.	Specific Gravity	1.12	As per submitted sample

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2.1.7 Water:

The Water used in the laboratory for trial cast is potable.

2.2 Design Stipulation

Table 9 Design Stipulation

a.	Type of cement	:	OPC 53 Grade
b.	Maximum Nominal size of Aggregate	:	20 mm
c.	Maximum water cement ratio	:	0.40 (As per IS-456-2000)
d.	Workability	:	500 ± 50 mm (slump in 3 Hrs.)
e.	Exposure condition	:	Moderate
f.	Method of concrete placing	:	Transit mixer
g.	Type of aggregate	:	Crushed Aggregate.
h.	Chemical admixture type	:	CAC Hyperfliud plus G

2.3 Blending of Aggregate

2.3.1 All in Aggregates

The aggregates are proportioned by varying percentage of each ingredient, so as to produce cohesive & workable mix and to meet the requirements of IS-383-2016 as well. The proportion finalized is 44.00: 56.00 (FA:CA).

Sieve Size	% of different fraction		% Passing for graded Aggregate	
(mm)	12.5 mm @ 45.0 %	20 mm @ 55.0 %	Combined	Specification as per IS-383-2016 Table 7
40 mm	45	55	100	100
20 mm	45	53.14	98.14	90-100
10 mm	43.76	4.92	48.69	25-55
4.75 mm	5.88	0.17	6.05	0-10

Fine Aggregate :
Confirming to Grading Zone-II Table -9 of IS-383-2016

2.4 Target strength for mix proportioning

Target Compressive Strength, f´ck = fck + 1.65*s Where, f´ck = Target Compressive strength at 28 days
fck = Characteristic compressive strength at 28 days s = Assumed standard deviation
Assumed standard deviation for M-60 grade concrete is 5 (AS Per IS -10262 -2009)
Hence, Target Compressive Strength = 60 +1.65*5 = 68.25 N/mm²

2.5 Selection Of Water Cement Ratio

From table 5 of IS-456, maximum W/C ratio = 0.40
Based on the experience and restrictions of strength, durability as well as workability parameter, adopt W/C ratio =0.293
0.293 < 0.40 Hence OK.

2.6 Selection Of Water Content

From table-2 of IS-10262-2009, max. Water content for 20 mm aggregate =186 Ltr. (For 25 to 50 mm slump range)
Estimated water content for required flow = (As per IS 10262-2009.point no.4.2) A superplastizer is used, for the flowable concrete. Design the mix with water content For 158 Ltr.

2.7 Calculation Of Cement Content

Water Cement ratio = 0.293
Hence Cementatious Content = 158/0.293 = 539.2 kg/m³ say 540 kg/m3
Cement content = 540 x 70.37 = 380.2 kg/m³ say 380 kg/m3
Flyash content = 540 x 24.07 = 130.1 kg/m³ say 130 kg/m3

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Alccofine content = 540 x 5.6 = 30 kg/m³ say 30 kg/m3
As per IS-456-2000, Minimum cement content = 360 kg/m³ 540 kg/m³ > 360 kg/m³ Hence OK

2.8 Proportion Of Volume Of Coarse And Fine Aggregate
From table-3 of IS-10262-2009, volume of coarse aggregate corresponding to 20 mm size of aggregate and fine aggregate zone-II for water cement ratio of 0.5 is 0.62
Therefore corrected proportion of volume of coarse aggregate for the W/C 0.293 = 0.601
Hence volume of fine aggregate content = 1- 0.601 = 0.399

2.9 Mix Calculations
The mix calculation per unit volume of concrete shall be as follows,

a. Volume of Concrete = 1 m³

b. Volume of Cement = (Mass of Cement/Specific gravity of cement)*(1/1000)

= (380/ 3.15)*(1/1000)

= 0.121 m³

c. Volume of Flyash = (Mass of Flyash /Specific gravity of flyash)*(1/1000)

= (130/2.16)*(1/1000)

= 0.060 m³

d. Volume of Alccofine = (Mass of Alccofine/Specific gravity of Alccofine)*(1/1000)

= (30/2.84)*(1/1000)

= 0.011 m³

e. Volume of Water = (Mass of Water/Specific gravity of Water)*(1/1000)

= (158/1.0)*(1/1000)

= 0.158 m³

f. Volume of Admix. = (Mass of Admix./Specific gravity of Admix.)*(1/1000) (@0.95% of Cementatious) = (5.13/1.12)*(1/1000)

= 0.005 m³

g. Volume of all in aggregates = [a - (b + c + d + e+f)]

[1 – (0.121 + 0.060 + 0.011 +0.158 +0.003)]

0.647 m³
h. Mass of Coarse aggregates = f * Volume of C.A.* Sp. Gr. Of C.A.*1000

= 0.647*0.601*2.91*1000

= 1131 kg

Mass of 20 mm aggregates = 1131*0.55 = 622 kg

Mass of 10 mm aggregates = 1131*0.45 = 509 kg

i. Mass of Fine aggregates= f * Volume of F.A.* Sp. Gr. Of F.A.*1000

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= 0.647*0.399*2.87*1000

= 740 kg

Mass of the Crushed sand = 740 kg

2.10 Mix Proportion For Trials

As the Cementatious content 540 kg/ m³ is sufficient to achieve the target strength, Durability parameter required for M-60 grade of concrete. During trial, the desired workability is achieved by altering the dosages of plasticizer.

2.11 Recommended Trial

Conducted with water cement ratio 0.293 with 0.95% admixture dosage.

Sr. No.	Ingredients	Weight Kg/m³	Moisture (%)	Water Absorption (%)	Correction (kg)	Corrected wt. (kg/m³)
a	Cement	380	0	0	0	380
b	Flyash	130	0	0	0	130
c	Alccofine	30	0	0	0	30
d	20 mm	622	0	1.44	-9.0	613
e	10 mm	509	0	1.51	-7.69	501
f	Crushed sand	740	0	2.62	-19.4	721
g	Water	158	0	0	+36	194
h	Admixture	5.13	0	0	0	5.13

Note : Aggregates calculation in saturated surface dry condition

The trial conducted on materials and the properties of fresh and hardened concrete such as workability and compressive strength are observed for Recommendation trial. The results are tabulated as below,

Properties	Recommended Trial	Specification
Water Cement ratio	0.293	----
cementitious Content	540	
% Content		
Cement (%)	70.37	
Flyash (%)	24.07	
Alccofine (%)	5.6	
Ratio of Fine : Coarse	44 : 56	----
Ratio of 20mm:10 mm	55 : 45	----
Proportions	Kg/m^3	----
Cement (kg)	380	----
Flyash (Kg)	130	----
Alcocfine (kg)	30	----
20 mm (kg)	622	----
10 mm (kg)	509	----
Crush Sand (kg)	740	----
Water (kg)	158	----
Admixture (kg)	5.13	----
Mix Texture	Cohesive	----

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Workability/Slump/Flow (mm)	Without Tamping	With Tamping	
Initial Flow	610	-	500 mm at 3 Hours
30 min. Flow	590	-	
60 min. Flow	570	-	
90 min. Flow	550	630	
120 min. Flow	520	610	
150 min. Flow	480	560	
180 min. Flow	450	520	
7 days Avg. Compressive Strength (N/mm²)	62.0		28 Days > 74 Mpa
28 days avg. Compressive Strength (N/mm²)	86.2		
Water Permeability (mm)			< 12 mm
28 Days	8		
RCPT (Charge Passed in Coulombs)			<1000 Coulombs
28 Days	450		

Note : Aggregates calculation in saturated

III. SUMMARY

In the present study, Alcco ne is used as a replacement of Cement to achieve max-imum Compressive as well as Flexural Strength, and an analysis has been done to study the performance of the Material.

IV. CONCLUSION

4.1Concrete Mix M 60 with cementatious content 540 kg/m³, (Alccofine 30 kg /m3) water cement ratio 0.293 and admixture 0.95 % dosage by weight of the cementatious content is recommended.

4.2 The water content is recommended for SSD condition of aggregates. In order to maintain the workability, proportionate adjustment for water absorption & surface moisture in the quantity of water shall be made for day to day production.

4.3 The grading of coarse and fine aggregates shall be checked regularly & should nearly match the grading of aggregate maintained during trial mix.

4.4 The plasticizer used shall be CAC Hyperfliud plus G.

4.5 The quality of water to be used for concreting shall confirm to IS: 456-2000.

4.6 At site, It is suggested to use suitable vibrators for compaction.

4.7 The Admixture dosage shall be adjusted according to pouring lead.

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