

## A Review on Alccofine : A supplementary cementitious material

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**Abstract**— Supplementary cementitious materials (SCM) are becoming popular in the construction industry 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 cementitious 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 where as Alccofine 1101 can be used as a grouting purpose.

**Keywords**— Alccofine, Silica fume, Ultrafine slag, SCM, High strength concrete

### I. INTRODUCTION

High strength and high performance concrete are gaining popularity day by day in the construction industry worldwide. 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 as cohesive and sticky mixes are equally difficult to place and compact fully and effectively. So the water to be used in the mix posses to have critical limit below which high HRWR dosage become undesirable and is harmful from the durability considerations. Mostly SCM like silica fume etc are proposed against HRWR where high strength of concrete mix, low permeability are the main consideration for developing high strength concrete mix. But these are often ineffective by the increased water or admixture dosage for workability of the green concrete.[1]

*Table 1. Types of Alccofine*

ALCCOFINE	SCM ALCCOFINE-1203	LOW CALCIUM SILICATE
	GROUTING ALCCOFINE-1101	HIGH CALCIUM SILICATE

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 Micro fine products Pvt. Ltd [2] ( A joint venture with ambuja cement ltd andalcon developers). 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 of Alccofine with low calcium silicate and high calcium silicate respectively. Alccofine 1200 series is of 1201, 1202, 1203 which represents fine, micro fine, ultrafine particle size respectively. Alccofine 1203 is slag based SCM having ultra fineness with optimized particle size distribution whereas Alccofine 1101 is a micro finer

cementitious grouting material for soil stabilization and rock anchoring. The performance of Alccofine 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 form additional C-S-H gel which similar to pozzolans. The computed blain value based on particle size distribution (PSD) is approximately 12000cm<sup>2</sup>/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.

**Table 2. Physical parameters of Alccofine 1203**

Specific gravity	Bulk Density (kg/m <sup>3</sup> )	Partical size distribution (μ )		
		d 10	d 50	d90
2.9	600-700	1-2	4-5	8-9

**Table 3. Chemical parameters of Alccofine 1203**

CaO	Al <sub>2</sub> O <sub>3</sub>	SIO <sub>2</sub>	Glass content
31-33 %z	23-25 %	33-35 %	>90%

**Applications - Alccofine 1101 Micro fine Cement-Grout**

- It is used in Tunnels, caverns, mines, etc. as Rock injection:
- It can be used for pre and post excavation injection.
- It can also be used for soil stabilization and sealing of ground water
- Soil injection
- Pre packed injection
- Contact injection

**Benefits of Alccofine 1101**

- Standard cement injection equipment can be used to perform grouting.
- It has better penetration in tight joints, fissures and pore spaces.
- Greater penetration imparts greater water tightness.
- Its rate of setting is very high.
- Better working environment and no hazardous components
- It is Durable
- It is found to be an economical solution.

**Applications of Alccofine 1203**

- 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

**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 ingress 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.
- Project Chennai metro Alccofine 1101 micro fine cement grout is being used.

**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: Results are taken from study carried by **Counto Micro fine Products PVT. LTD** [2] (A joint venture with Ambuja cement ltd and alcon developers)

**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.

In these three methodologies binders are OPC – 430 kg, Fly Ash – 80kg and alternately using ALCCOFINE 1203 – 40kg and Silica Fume – 40kg as total binder content. The amount of total cementitious content was considered constant at 550 kg/m<sup>3</sup>. Coarse aggregate used was crushed basalt rock and fine aggregate used was local river sand . These materials were dried completely before using. The HRWR used was Polycarboxylate ether. Considering typical mix design, the further changes were carried out as per the described methodologies.

*Table 4. Typical Mix Design Mass of Constituents (kgs)*

Materials	Reference Mix Silica Fume	Sample mix ALCCOFINE 1203
Cement	430	430
Fly Ash	80	80
Silica Fume	40	0
Alccofine1203	0	40
Water	160	160
Admixture	4	4

*Table 4 A. Materials Used For Experiment*

Material	Brand Name	Product
Cement	ACC	43 Grade OPC
Fly Ash	Dirk (I) Pvt. Ltd.	P 60
Silica Fume	ORkLA (I) Pvt.Ltd. (Formerly known as Elkem India Pvt.Ltd.)	920 D
Admixture	Glenium BASF	B - 244

**Table 5. The Effect of ALCCOFINE1203 addition on compressive strength and workability of concrete specimen with equal water/binder ratio.**

Reference mix silica fume		Sample mix ALCCOFINE 1203
<b>Slump (mm)</b>		
Initial	180	210
30 min	150	210
60 min	110	150
90 min	90	120
120 min	60	95
<b>Compressive strength (MPa)</b>		
1 Day	20.4	20.58
3 Day	38.29	45.11
7 Day	49.83	55.72
28 Day	64.17	67.44
56 Day	68.25	70.42

**Table 6. The effect of ALCCOFINE 1203 on the water required to maintain a constant slump. Assessment of Water Requirement**

Materials	Reference Mix Silica Fume	Sample mix ALCCOFINE 1203
Cement	435	435
Fly Ash	80	80
Silica Fume	40	0
Alccofine1203	0	40
Water	160	155
Admixture	4	4

**Table 7: Compressive strength and workability of concrete specimen with constant binder and HRWR content Slump (mm)**

Reference mix Silica Fume	Sample mix ALCCOFINE 1203	
Initial	190	200
30 min	155	160
60 min	120	130
90 min	95	110
120 min	65	80
<b>Compressive strength(MPa)</b>		
1 Day	21.3	23.54
3 Day	38.75	47.2
7 Day	50.02	60.42
28 Day	64.50	70.47
56 Day	68.50	74.44

**Table 7. Assessment of HRWR required for a concrete specimen at constant water /binder ratio**

Materials	Reference Mix Silica Fume	Sample mix ALCCOFINE 1203
Cement	430	430
Fly Ash	80	80
Silica Fume	40	0
Alccofine1203	0	40
Water	160	160
Admixture	4	3.00

**Note:- Contents in kg/m**

**Table 8. Workability and compressive strength of concrete specimen at constant water / binder ratio. Slump (mm)**

Reference mix Silica Fume	Sample mix ALCCOFINE 1203	
Initial	185	195
30 min	150	165
60 min	125	130
90 min	100	115
120 min	60	75
<b>Compressive strength(MPa)</b>		
1 Day	20	22.58
3 Day	38.95	46.12
7 Day	49.23	54.72
28 Day	63.57	68.64
56 Day	68.05	72.52

Cost analysis for a standard Mix of M60 with Alccofine 1203 V/s silica fume

**Table 9. Cost analysis of Alcco fine concrete**

		<b>MIX Without ALCCOFINE 1203-A</b>		<b>MIX With ALCCOFINE 1203-B</b>	
Item	Rate/kg	Cement+ Silica fume+ FA	Cost /Cum	Cement+ALCCOFINE 1203+FA	Cost per Cum
Cement	5	430	2150	430	2150
Silica fume	25	50	1250	0	0
Alccofine	25	0	0	50	1250
Fly ash	15	80	120	80	120
Admixture	130	767	997.1	5.59	726.7

Net savings = 4517.10 – 4246.7 = 270.40 kg

### III. CONCLUSION DRAWN

The conclusion from the experiment can be drawn that Alccofine being use as mineral admixture in a concrete mix increase the initial strength of the concrete than the ordinary concrete. The concrete posses high workability and retain the workability for sufficient time. Alccofine is easy to use and can be added directly with cement, ultrafine particle of Alccofine provide better and smooth surface finish. For high strength concrete the cost of the concrete mix prepared with Alccofine is lesser than the concrete without Alccofine. It also lower the water/binder ratio.

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