Research Paper Engineering

Study on Strength Development of High Strength Concrete Containing Alccofine and Fly-Ash

*Suthar Sunil B ** Dr. (Smt.) B. K. Shah

* Post graduate student of M.E. (structural engineering), birla vishvakarma mahavidyalaya engineering college, vallabh vidyanagar-388120 Gujarat

** Associate Professor, Structural Engineering, B.V.M, V.V. Nagar, Gujarat,India

ABSTRACT

This paper presents the results of an experimental investigation carried out to evaluate the compressive strength of High Strength Concrete. High Strength Concrete is made by partial replacement of cement by alccofine and fly-ash. In this study the Class F fly ash used in various proportions 0, 20, 25, 30, 35% and that of Alccofine by 0, 4, 6, 8, 10, 12, and 14% by weight of cement. The mix proportions of concrete had a constant water binder ratio of 0.4 and super plasticizer was added based on the required degree of workability. The total binder content was 425 kg/m3. The concrete specimens were cured on normal moist curing under normal atmospheric temperature. The compressive strength was determined at 56 days. The results indicate the concrete made with these proportions generally show excellent fresh and hardened properties since the combination is somewhat synergistic. The addition of Alccofine shows an early strength gaining property and that of fly ash shows long term strength. The ternary system that is Ordinary Portland cement-fly ash-alccofine concrete was found to increase the compressive strength of concrete on all age when compared to concrete made with fly ash and Alccofine alone.

Keywords : Compressive strength, High Strength concrete, fly ash, Alccofine

INTRODUCTION

Fly ash is widely used in blended cements, and is a by-product of coal-fired electric power plants. Two general classes of fly ash can be defined: low-calcium fly ash (LCFA: ASTM class F) produced by burning anthracite or bituminous coal; and high-calcium fly ash (HCFA: ASTM class C) produced by burning lignite or subbituminous coal. Utilization of waste materials such as fly ash in construction industry reduces the technical and environmental problems of plants and decreases electric costs besides reducing the amount of solid waste, greenhouse gas emissions associated with Portland clinker production, and conserves existing natural resources.Despite the benefits of fly ash, practical problems remain in field application. At early stages of aging, the strength of concrete containing a high volume of fly ash as a partial cement replacement is much lower than that of control concrete, due to the slow pozzolanic reactivity of fly ash.

Newly developed admixtures allow lowering the water/binder ratio to very low-levels without loss of workability. By incorporation of super plasticizers, the strength development of fly ash concrete can be accelerated to achieve the desired performance at early ages by adding accelerating agents such as Alccofine,metakaolin, slag, silica fume etc. ALCCOFINE 1203 is a specially processed product based on slag of high glass content with high reactivity obtained through the process of controlled granulation. Due to its unique chemistry and ultra fine particle size, ALCCOFINE1203 provides reduced water demand for a given workability, even up to 70% replacement level as per requirement of concrete performance. ALCCOFINE 1203 can also be used as a high range water reducer to improve compressive strength or as a super workability aid to improve flow. Alccofine1203 is known to produce a high-strength concrete and is used in two different ways: as a cement replacement, in order to reduce the cement content (usually for economic reasons); and as an additive to improve concrete properties (in both fresh and hardened states). Therefore, utilization of Alccofine1203 together with fly ash provides an interesting alternative and can be termed as high strength and high performance concrete.

One of the main advantages of mineral admixtures in high-strength concrete is reducing the cement content, which is not only economic and environmental benefits but also means reducing the rise in temperature at the same time increasing the compressive strength and durability properties. As a rule of thumb, the total temperature produced by the pozzolanic reactions involving mineral admixtures is considered to be half as much as the average heat produced by the hydration of Portland cement.

This paper reports the results of an experimental investigation of compressive strength of blended cements. Twenty Four concrete mixtures were made in this investigation. These included a control mixture, mixture containing 0, 20, 25, 30, 35% fly ash alone as cement replacement (C+F), mixtures with 0, 4, 6, 8, 10, 12, and 14% alccofine alone as replacement for cement (C+A), and a mixture combining both fly ash and alccofine as cement replacement (C+F+A) as given in the Table 6. The water-cementitious materials ratio was kept constant at 0.40 for all mixtures; super plasticizer was added on different dosages based on the degree workability to be obtained. A large number of cube specimens were casted and subjected to normal curing at atmospheric temperature after demoulding. The compressive strength was determined at 56 days.

2. Experimental Study

The experimental study carried out at the laboratory is explained as given below

2.1 Concrete Materials The concrete mixtures were made using the following materials:

Cement Ordinary Portland cement 53 Grade was used.

TABLE-1
PROPERTIES OF OPC - 53 GRADES USED

Properties		Value	As per IS: 12269-1976
Specific gravity		3.10	3.15
Normal consistency		31%	30% - 35%
Initial setting time		36	>30
Final setting time		450	<600
Fineness (%passing 90 IS sieve)		3%	<10%
Soundness (mm)		1.2	<10
Compressive strength	3 day	39	>27
	7 day	40	>37
	28 day	57	>53

Fly ash Fly ash (ASTM Class F) from Wanakbori thermal power station,kheda,Gujarat,INDIA

Alccofine 2103 Ambuja cement Ltd., Mumbai.

TABLE-2
PHYSICAL & CHEMICAL PROPERTIES OF ALCCOFINE:

Fineness (cm^2/gm)	Specific Gravity	Bulk Density (Kg/m^3)
>12000	2.9	700-900
Particle Size Distribution		
d10	d50	d90
1.5 micron	5 micron	9 micron
Chemical Properties:		
C_aO	SO_3	SiO_2
61-64%	2-2.4 %	21-23 %
AL_2O_3	Fe_2O_3	M_gO
5-5.6 %	3.8-4.4 %	0.8-1.4 %

Aggregates The fine and coarse aggregates were local natural sand and crushed gravel, respectively. The fine and coarse aggregates were sieved into different size fractions that were then recombined to a specific grading. The grading and the physical properties are in conformity with the I.S Methods.

Superplasticizer (SP) A new generation Poly-Carboxylic Ether (PCE) based super-plasticizer was used. This super -plasticizer is available as a medium brown colored aqueous solution.

2.2 Mixture Proportions The concrete mixture proportions are given in Table 3 for 425 kg/m3. The total binder content was kept as 425 kg/m3 and a constant W/B of 0.4. The CF series, cement was replaced at 20, 25, 30, 35% proportions with FA. In the CA series the cement was replaced with alccofine, at 0, 4, 6, 8, 10, 12, and 14%. Finally, CFA series both fly ash and alccofine were added by cement weight.

TABLE-3
MIX PROPORTION AS PER IS: 10262:2009

Cement	425 kg/m^3
Water	170 kg/m^3
Fine aggregate	838 kg/m^3
Coarse aggregate	1096 kg/m^3
Water-cement ratio	0.4

2.3 Casting and Testing of Specimens
For each mix of concrete, three concrete cube specimens were cast each of size 150mmx150mmx150mm. To obtain a homogeneous mix, aggregates were mixed and binders (cement, FA and AL) were added to the system. After remixing, water was added to the dry mix. Finally, super plasticizer was introduced to the wet mixture. In the fresh concrete slump cone test was performed to ensure the workability. Cube specimens were used to Determine the compressive strength. The molded specimens were left in the casting room at 27°C for 24 h. They were then demoulded and cured. The cube specimens were cured for age's 56days period to determine the compressive strength at these ages. Figure 1 shows the view of compressive testing machine along with the specimen.

TABLE-4
OPC+ALCCOFINE (W/C=0.4, WATER=170KG)

MIX NO	MATERIALS		
	OPC KG	ALCCOFINE KG	STRENGTH (Mpa)
1	100% 425.0	0% 0	32.1
2	96% 408.0	4% 17.0	35.41
3	95% 387.6	5% 20.4	37.94
4	94% 364.3	6% 23.3	40.44
5	93% 338.8	7% 25.5	44.81
6	92% 311.7	8% 27.1	41.24
7	91% 283.7	9% 28.1	34.14
8	90% 255.3	10% 28.4	34.09
9	89% 227.2	11% 28.1	33.15

TABLE-5
OPC+FLY-ASH (W/C=0.4, WATER=170KG)

Mix No	MATERIALS		STRENGTH
	OPC	FLYASH	(mpa)
10	100% 425.0	0% 0.0	32.1
11	80% 340.0	20% 85.0	41.5
12	75% 255.0	25% 85.0	45.7
13	70% 178.5	30% 76.5	40.2
14	65% 116.0	35% 62.5	38.6

TABLE-6
OPC+ALCCOFINE+FLY-ASH (W/C=0.4, WATER=170KG)

Mix No	MATERIALS			C(mpa)
	OPC	A	FA	
15	100 425	0% 0	0% 0	32.10
16	70% 297.50	6% 25.50	20% 85.00	41.60
17	65% 276.25	6% 25.50	25% 106.25	42.49
18	78% 331.50	6% 25.50	30% 127.50	40.06
19	76% 323.00	7% 29.75	20% 85.00	43.84
20	73% 310.25	7% 29.75	25% 106.25	50.74
21	71% 301.75	7% 29.75	30% 127.50	42.39
22	70% 297.50	8% 34.00	20% 85.00	37.78
23	65% 276.25	8% 34.00	25% 106.25	40.19
24	78% 331.50	8% 34.00	30% 127.50	36.42

Graph-1 OPC+ALCCOFINE+FA

2.3 Casting and Testing of Specimens:
For each mix of concrete, three concrete cube specimens were cast each of size 150mmx150mmx150mm. To obtain a homogeneous mix, aggregates were mixed and binders (ce-

ment, FA and AL) were added to the system. After remixing, water was added to the dry mix. Finally, super plasticizer was introduced to the wet mixture. In the fresh concrete slump cone test was performed to ensure the workability. Cube specimens were used to determine the compressive strength. The molded specimens were left in the casting room at 27°C for 24 h. They were then demoulded and cured. The cube specimens were cured for age's 56days period to determine the compressive strength at these ages. Figure 1 shows the view of compressive testing machine along with the specimen.

Figure-1 COMPRESSION TESTING MACHINE

3. Conclusion:

It is apparent that ternary cementitious blends of Ordinary Portland cement, Alccofine, and fly ash offer significant advantages over binary blends and even greater enhancements over plain Portland cement. The combination of Alccofine and fly ash is complementary: the alccofine improves the early age performance of concrete with the fly ash continuously refining the properties of the hardened concrete as it matures. In terms of durability, such blends are vastly superior to Ordinary Portland cement concrete.

- From ternary result MIX NO 20 in which 7% AL and 25% FA give high result compare with binary MIX NO 5 and MIX NO 12.
- The relatively low cost of fly ash offsets the increased cost of alccofine.

REFERENCES

[1] Predicting the Strength Properties of High Performance | Concrete Using Mineral and Chemical Admixtures | 1 M. Vijaya Sekhar Reddy, 2 I.V. Ramana Reddy, 3 N.Krishna Murthy | [2] The Effect Of Mineral Admixture Type On The Modulus Of Elasticity Of High Strength Concrete | Kür_At Yıldız1* and Latif Onur U_Ur2 | [3] Performance of Admixtures On Strength Properties Of High Performance Concrete | M. Vijaya Sekhar Reddy#1, Dr. I.V. Ramana Reddy#2, K. Madan Mohan Reddy#3, C.M. Ravi Kumar#4 | [4] Experimental Investigation on Ultra High Strength Concrete Containing Mineral Admixtures under Different Curing Conditions | Arunachalam. K1, Vigneshwari.M2 | [5] Indian Standard Specification for Granulated Slag For Manufacture Of Portland Slag Cement. IS 12089:1987, Bureau Of Indian Standards, New Delhi. | [6] "Indian Standard Plain And Reinforced Concrete - Code Of Practice". IS 456:2000, Bureau of Indian Standards, New Delhi | [7] IS: 10262-1982 Recommended Guidelines For Concrete Mix Design, Fifth Reprint March-1998, Bureau Of Indian Standards, New Delhi. | [8] IS: 2386 (Part I)-1963, Methods of Test for Aggregates for Concrete, Part I: Particle Size and Shape, Tenth Reprint March 1993, Bureau Of Indian Standards, New Delhi. | [9] IS: 516-1959, Methods Of Tests For Strength Of Concrete, Bureau Of Indian Standards, New Delhi. |