

High Performance Concrete with Partial Replacement of Cement by ALCCOFINE & Fly Ash

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Abstract- Although fly ash as a partial replacement for cement has been utilized for many years, it has been almost exclusively used in low-volume percentages, such as 10 or 20% cement replacement. In this study cement is partially replaced by ALCCOFINE and fly ash for M70 grade of concrete. The compressive strength of concrete of OPC concrete and with ALCCOFINE and fly ash is compared and it has been found that the strength of concrete got increased by 20% with partial replacement of cement by ALCCOFINE.

Key word: - HPC, fly ash, ALCCOFINE

1 INTRODUCTION

With an annual production exceeding 2 billion metric tons per year, concrete is the single most widely used manufactured substance on earth owing to its remarkable versatility as a building material (Crow 2008). Concrete is typically the most massive individual material element in the built environment. If the embodied energy of concrete can be reduced without decreasing performance or increasing cost, significant environmental and economic benefits may be realized. Concrete is primarily comprised of Portland cement, aggregate, and water. Although Portland cement typically only comprises 12% of the concrete mass, it accounts for approximately 93% of the total embodied energy of concrete and 6 to 7% of the worldwide CO₂ emissions (Mehta 1998). A large numbers of papers available with replacement of cement with fly ash In this paper strength of concrete is investigated. In high performance concrete applications, Silica Fume is generally proposed as the appropriate cement extender where high strength, low permeability are the prime requirements. Though silica fume is known to improve durability, its addition in concrete is often negated by the increase water and/or admixture dosage required to improve the workability and handling properties of the fresh

concrete. This paper focus on partial replacement of cement with fly ash and ALCCOFINE 1203. This replacement increase the strength, durability, resistance to chemical attack of concrete.

2 MATERIALS

53 grade Ordinary Portland cement conforming to BIS 12269-1987 is used. Fly ash (or) pulverized fly ash is used which is a residue remains obtain from the combustion of pulverized coal collected by mechanical separators, from the fuel gases of thermal plants.

The coarse aggregate chosen for High performance concrete is typically round in shape, is well graded, and smaller in maximum size than that used for conventional concrete typical conventional concrete could have a maximum aggregate size of 20 mm or more. Polycarboxylate ether (PCE) type is very efficient dispersants for Calcium Aluminate cement based constables. They provide superb workability to the material in the fresh state, and excellent physical properties in the hardened state. ALCCOFINE 1203 is a specially processed product based on slag of high glass content with high reactivity obtained through the process of controlled granulation. The raw materials are composed primary of low calcium silicates. The processing with other select ingredients results in controlled particle size distribution (PSD). The computed plain value based on PSD is around 12000 cm²/gm and is truly ultra fine. 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. In this paper Compressive strength of OPC concrete is compared with concrete with ALCCOFINE.

2.1 Properties of ALCCOFINE

The chemical composition and physical characteristics listed in Table 1, ALCCOFINE 1203

A Special Issue of 1st Int. Conf. on Recent Trends & Research in Engineering and Science

By: Padm. Dr. V. B. Kolte College of Engineering & Polytechnic, Malkapur on 21-23 March, 2015

has got the unique chemical composition mainly of CaO 31-33% and SiO₂ 33-35%. Physically the product is unique with regards to its particle size

distribution. Figure: 1, demonstrates the comparative particle size distribution analysis.

Table 1: Properties of ALCCOFINE

Chemical Analysis	Mass %	Physical analysis	Range
CaO	32-34	Bulk Density	600-700 kg/m ³
Al ₂ O ₃	18-20	Surface Area	12000 cm ² /gm
Fe ₂ O ₃	1.8-2	Particle shape	Irregular
SO ₃	0.3-0.7	Particle Size, d ₁₀	< 2 μ
MgO	8-10	d ₅₀	< 5μ
SiO ₂	33-35	d ₉₀	< 9 μ

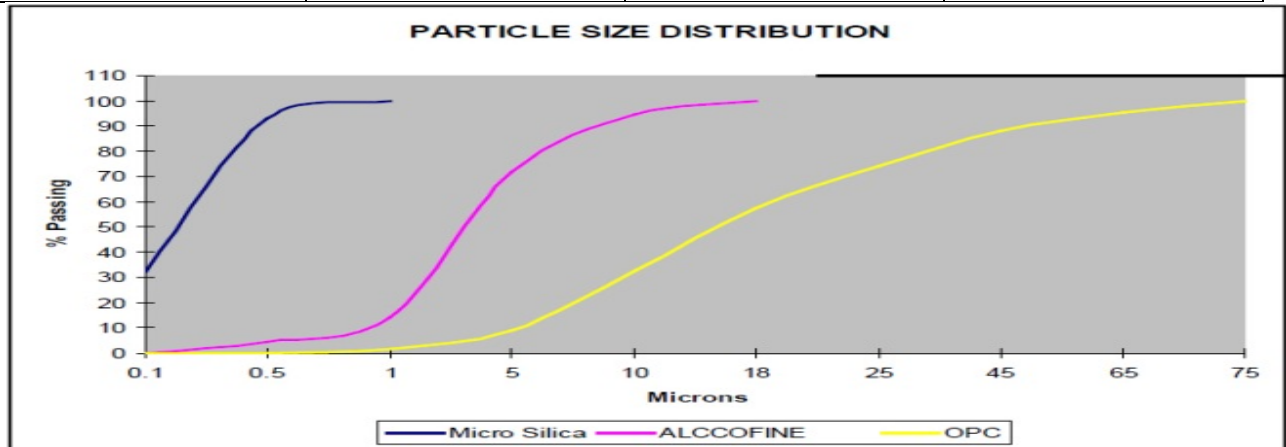


Figure. 1 Particle Size Distribution

3 MIX DESIGN CASTING AND CURING

Concrete is designed for M70 table 2 shows percentage constituting of each material. After mix design concrete cement is tested for setting time and concrete is tested for workability. Specimen

size of concrete sample for compressive strength test was taken as 100.0 mm X 100.0 mm X 100.0 mm to make better control. After 24 hrs of casting the cubes were demoulded and kept in normal tap water for curing.

Table 2:Batching of concrete mixes (0.025m³)

Designation (M70)	OPC (kg)	PFA. (kg)	Alcoo (kg)	C.A 20mm (kg)	C.A 10mm (kg)	CSS. (kg)	N. Sand (kg)	Water (kg)	Admixture (gm.)
OPC+PFA+ALCOFINE	11.75	2.50	1.25	7.47	17.46	9.90	10.00	3.63	157

OPC+PFA	11.25	4.25	0.00	7.39	17.28	9.80	9.90	3.63	171
OPC	15.50	0.00	0.00	7.47	17.46	9.90	10.00	3.94	171

4 RESULTS AND DISCUSSION

Concrete cubes are tested for compressive strength in CTM after 7 days and 28 days. Table shows compressive strength of cubes while figure shows comparison between OPC concrete and concrete with

ALCCOFINE and flyash. Our 2nd trial was failed because it was not take proper initial strength; the flyash content which are used for this trial is up 30 %. So as per IS suggestions fly ash is use up to 30-35% but it not in case of high performance concrete.

Table 3. Compressive strength results 7 days

DESIGNATION	GRADE	CAST DATE	TEST DATE	AGE AT TEST	COMPRESSIVE STRENGTH N/MM ²	NOMINAL DENSITY KG/M ³
OPC+PFA+ALCOFINE	M70	13.01.15	20.01.15	7	53.90	2512
OPC+PFA+ALCOFINE	M70	13.01.15	20.01.15	7	54.67	2522
OPC+PFA+ALCOFINE	M70	13.01.15	20.01.15	7	55.67	2527
OPC+PFA	M70	13.01.15	20.01.15	7	DISCARDED	–
OPC+PFA	M70	13.01.15	20.01.15	7	DISCARDED	–
OPC+PFA	M70	13.01.15	20.01.15	7	DISCARDED	–
PURE OPC	M70	13.01.15	20.01.15	7	58.56	1387.0
PURE OPC	M70	13.01.15	20.01.15	7	60.10	1422.8
PURE OPC	M70	13.01.15	20.01.15	7	58.70	1408.5

Table 4: Compressive strength after 28 day.

Designation	Grade	Cast Date	Test Date	Age At Test	Compressive Strength N/Mm ²	Nominal Density Kg/M ³
OPC+PFA+ALCOFINE	M70	13.01.15	10.02.15	28	81.13	1212.8
OPC+PFA+ALCOFINE	M70	13.01.15	10.02.15	28	81.96	1236.0
OPC+PFA+ALCOFINE	M70	13.01.15	10.02.15	28	83.37	1252.6
OPC+PFA	M70	13.01.15	10.02.15	28	DISCARDED	–
OPC+PFA	M70	13.01.15	10.02.15	28	DISCARDED	–
OPC+PFA	M70	13.01.15	10.02.15	28	DISCARDED	–
PURE OPC	M70	13.01.15	10.02.15	28	76.09	1712.0
PURE OPC	M70	13.01.15	10.02.15	28	75.23	1692.7
PURE OPC	M70	13.01.15	10.02.15	28	76.52	1721.8

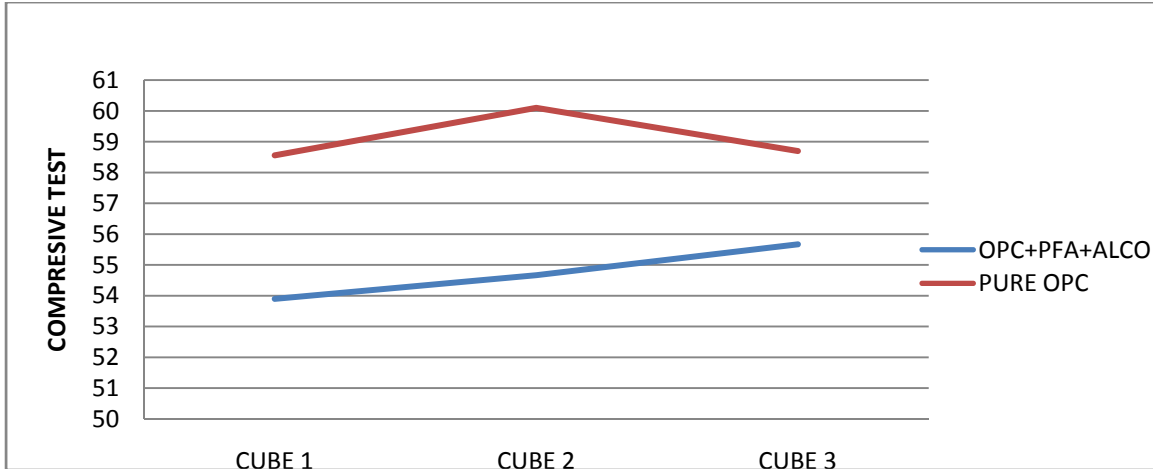


Figure 2: Variation in compressive strength at 7 days.

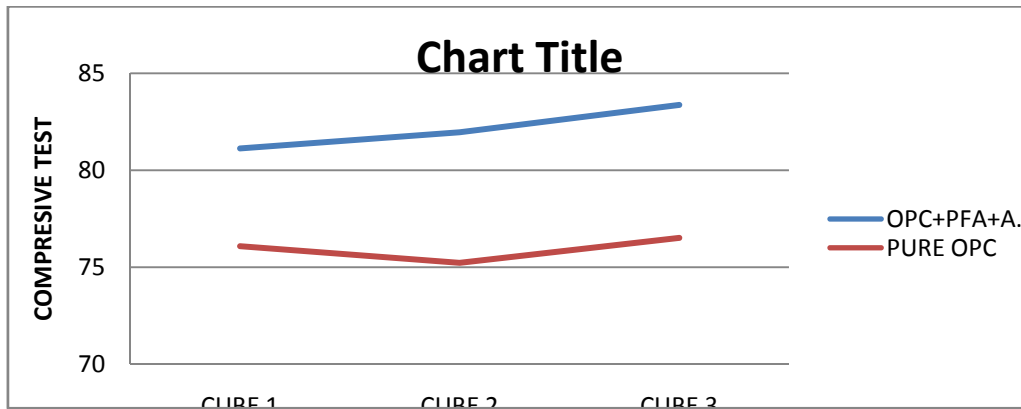


Figure 3: Variation in compressive strength at 28 days.

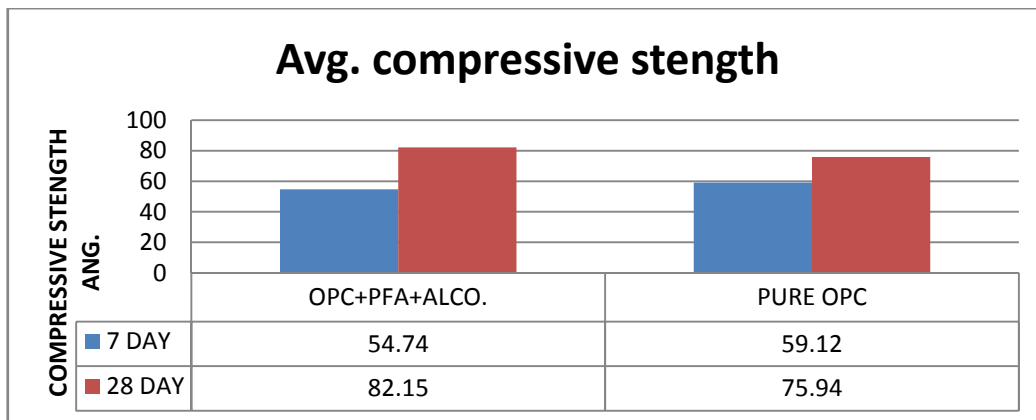


Figure 4: Average compressive strength at 7 and 28 days.

4 CONCLUSION

From the results of compressive strength test we conclude following points.

- The compressive strength of concrete increases with increase ALCCOFINE and flyash content in HPC up to 15-20 %.

- High density of the mix was achieved and subsequently higher packing value.
- Cube failure pattern was dumb bell showing aggregate crushing dominantly.

As per cost concern ALCCOFINE is cheaper than cement so for better strength and durability of

concrete it should be promoted in Indian construction industry.

ACKNOWLEDGEMENT

We are very thank full to RMC India Pvt. Ltd. Nashik for providing materials and testing facility at their firm.

ABBREVIATION

Following abbreviations are used in this paper.

OPC	Ordinary portland cement
PFA	Pure Fine Fly Ash

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