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Effect on Compressive strength of High Performance Concrete Incorporating Alccofine and Fly Ash

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Abstract:
This Paper Presents the Compressive strength of high performance concrete with the replacement of cement with Alccofine and Fly ash, and also with natural sand to manufactured sand. The necessity of high performance concrete is increasing because of demands in the construction industry. Efforts for improving the performance of concrete over the past few years suggest that cement replacement materials along with Mineral & chemical admixtures can improve the strength and durability characteristics of concrete. Alccofine (GGBS) and Fly ash is pozzolanic materials that can be utilized to produce highly durable concrete composites. The concrete specimens were cured on normal moist curing under normal atmospheric temperature. The compressive strength was determined at 3, 7 and 28 days. 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 ages when compared to concrete made with fly ash and Alccofine alone.

Key words: *Compressive Strength, Alccofine, Fly ash, manufactured sand*

1. Introduction

ALCCOFINE 1203 is a specially processed product based on slag of high glass content with high reactivity obtained through the process of controlled granulation. Owing 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 utilized 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.

Fly ash is commonly used in blended cements, and is a by-product of coal-fired electric power plants. The 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 sub bituminous coal. Utilization of waste materials such as fly ash in construction industry reduces the technical and environmental problems of plants and decreases electricity 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.

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 improving the compressive strength. This paper Report the results of an experimental investigation of compressive strength of concrete cubes. Two grades of concrete were made and for each grade of concrete having two different types of water cement ratio. These include a control mixture, mixture containing 4, 6,8,10 and 12% Alccofine as cement replacement and 30% fly ash constant as replacement of cement. A large

number of cubes were cast and subjected to normal curing at atmospheric temperature. The compressive strength determined 3, 7 and 28 days.

2. Experimental Program

Experimental program has been designed to provide results of Alccofine and fly ash with manufactured sand based high performance concrete. To check the performance of Alccofine and fly ash with manufactured sand based concrete have been studied in this investigation.

2.1. Material Used

- **Cement:-**Ordinary Portland cement-53 grade (Siddhi Cement) have used in the investigation. The cement was tested according to IS 4031:1988. It confirmed to IS 12269:1987. Its Properties is given in Table I

Sr No.	Properties	Value	As per IS:12269-1976
1	Specific Gravity	3.10	3.15
2	Normal Consistency	31%	30%-35%
3	Initial Setting time	36	>30
4	Final Setting time	450	<600
5	Fineness (%passing 90 IS sieve)	3%	<10%
6	Soundness (mm)	1.2	<10
7	Compressive Strength	39 (3 days)	>27
		40 (7 days)	>37
		57 (28 days)	>53

Table 1: Property of OPC 53 Grades

- **Fine Aggregate: -** Manufactured sand conforming IS: 383(1987) have used. Locally available manufactured sand having bulk density of 1860 kg/m^3 is used. The properties of fine aggregates are shown in below table.

Sr. No	properties	Result obtained
1	Specific Gravity	2.67
2	Fineness Modulus	3.03
3	Grading Zone	II
4	Water Absorption	1.13 %

Table 2: Properties of Fine Aggregate

- **Coarse Aggregate:-**Crushed aggregate confirming to IS: 383-1987 have used. Aggregates of size 20 mm and 10 mm of specific gravity 2.86 and fineness modulus 7.28 for 20 mm and 6.30 for 10 mm were used.

- **Alccofine:-**ALCCOFINE is a specially processed product based on slag of high glass content with high reactivity obtained through the process of controlled granulation. Alccofine have used conforming to ASTM C989-99. Physical and Chemical Properties,

Physical Properties		
Fineness (cm2/gm)		>12000
Specific Gravity		2.9
Bulk Density(Kg/m3)		700-900
Particle Size Distribution	d10	1.5 micron
	d50	5 micron
	d90	9 micron

Table 3: Physical properties of Alccofine

Chemical Properties	
CaO	61-64 %
SO_3	2-2.4 %
SiO_2	21-23 %
Al_2O_3	5-5.6 %
Fe_2O_3	3.8-4.4 %
MgO	0.8-1.4 %

Table 4: Chemical Properties of Alccofine

- **Fly Ash: -** It is obtained from Gujarat state electricity corporation limited.

Chemical Constituents	Percentages
Silica	62.12 %
Iron Oxide	6.48 %
Calcium Oxide	1.23 %
Titanium Oxide	16.0 %
Potassium Oxide	1.28 %
Magnesium Oxide	12.8 %
Phosphorous Pent oxide	0.49 %
Sulphur	0.36 %
Disodium oxide	0.28 %

Table 5: Chemical Properties of Fly-Ash

2.2. Mix Design

Alccofine varies from 4 to 12 % and fly-ash will be constant 30%. Finally as optimum dosage of Alccofine and Fly-ash is 8 or 10 % and 30% respectively.

Material	Volume (kg/m^3)
Cement	353.5
Fly Ash	151.5
Sand	680
10 mm Aggregate	450
20 mm Aggregate	558
Water	252.5

Table 6: Mix Design of M-60 Grade

2.3. Experimental Process

The specimen of standard cube has (150mmX150mmX150mm) used for compressive strength. The water binder ratio adopted was 0.45 and 0.5 Concrete cubes of 150X150X150mm dimension were casting for compressive strength. They have tested for compressive strength after 3, 7 and 28 days of water curing.

3. Results Obtained

The results of a ternary blend of compressive strength have presented in table 6. The test has carries out conforming to IS: 516 (1959) to obtain the compressive strength of concrete. From the table7 maximum compressive strength has observed at 10% Alccofine.

Mix	AF1	AF2	AF3	AF4	AF5	AF6	AF7	AF8	AF9	AF10
% of F.A	30 %	30 %	30 %	30 %	30 %	30 %	30 %	30 %	30 %	30 %
% of AF	4 %	6 %	8 %	10 %	12 %	4 %	6 %	8 %	10 %	12 %
w/c	0.45	0.45	0.45	0.45	0.45	0.5	0.5	0.5	0.5	0.5

Table 7: optimum Dosage of Alccofine + Fly Ash

Days	3	7	28
AF4	33.30 Mpa	46.6 Mpa	71 Mpa
AF9	38.5 Mpa	47.15 Mpa	73.8 Mpa

Table 8: maximum Compressive strength at different days

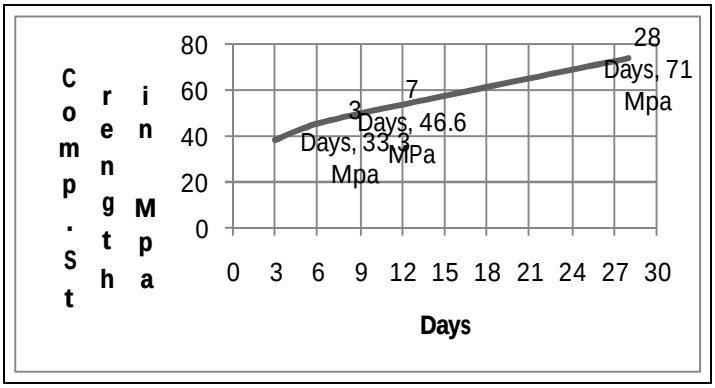

Figure 1: Maximum Compressive Strength of M-60 Grade at w/c: 0.45

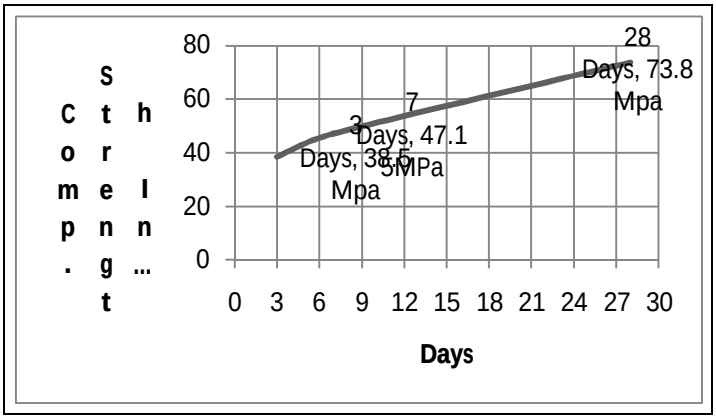

Figure 2: Maximum Compressive Strength of M-60 Grade at w/c: 0.5

4. Conclusion

- In this study the effect of Alccofine as a supplementary cementing material and filling material on the strength of concrete was investigated.
- The maximum compressive strength of concrete is achieved by using Alccofine 10% at Fly Ash 30%.
- In all mix proportions strength gain up to 3 days is good. Between 3 to 7 days the strength gain is excellent. Between 7 to 28 days strength gain comparatively slow or less.
- The addition of Alccofine increases the self compatibility characteristics like filling ability, passing ability and resistance to segregation.
- The relative cost of Alccofine is cheaper then cement hence it is also economic with higher strength.
- Due to Changes in w/c ratio 0.45 to 0.5 higher compressive strength is achieved in a minor difference.
- At 3 days higher w/c ratio gives higher strength compared to lower w/c ratio.
- Average compressive strength at 28 days for 0.5 w/c ratio gives 73.8 Mpa & 0.45 w/c gives 71.0 Mpa, Hence at aging compressive strength increment is not that much marginal.

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