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STUDY ON EFFECT OF MINERAL ADMIXTURES IN MIX PROPORTIONING OF HPC

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ABSTRACT:
In mix design of HPC, there are many factors considered in the selection of ingredients and their optimum proportions are difficult. The mix design process of HPC is more critical than that of Normal Strength Concrete (NSC) in view of high powder content and the requirement of low water cementitious binder (W/Cm) ratio. It is a comparative study of partial replacement of cement by mineral admixtures (Fly Ash, Micro Silica) for designing HPC mixes having compressive strength grade M60.
This present paper deals with the study of properties namely workability, compressive strength of (28th days) of M60 grade HPC mixes incorporating different percentages of Fly Ash, Micro Silica by weight of cement along with some suitable super plasticizer. The results of the study point toward that the workability and strength properties of HPC mixes improved by incorporating Fly Ash and Micro Silica up to desirable content of 10 % & 15% by weight of cement.

Key words: *Fly Ash (FA), Micro silica (MS), Super Plasticizer, Compressive Strength, Workability, HPC.*

1. INTRODUCTION:

The mix design of HPC is relatively more complex as it involves several ingredients. The methods of conventional mix design are not directly applicable to HPC. High performance concrete cannot be made by a slipshod approach because, each ingredient viz: cement, sand, aggregate, supplementary cementitious materials, super plasticizer, and the other admixtures must be carefully selected and checked due to their individual characteristics significantly affect the final properties of concrete.

The utilization of fly ash & Micro Silica as cement replacement material in concrete cement introduces many benefits from economical, technical and environmental points of view.

2. MATERIALS AND METHODS:

The main objective of this paper is to compare the properties of fresh and hardened concrete (HPC) made with mineral admixtures. The present investigation is carried out to study the workability and strength properties of high performance concrete mix of the M60, with a partial replacement of cement with Fly Ash and Micro silica. . The material used in making HPC mixes along with their various properties have been given in table 1

Material	Sp. Gravity	Fineness Modulus	Grade/ Type of cement	Compressive strength	Source
Cement	3.15	-	53 (OPC)	54 Mpa.	Ultratech Cement
Fine Aggregate	2.70	3.022	Zone-I	-	Krishna River
Coarse Aggregate	2.78	7.127	60%-20mm 40%-12.5mm	21.36% (Crushing Value)	Locally Available
Fly Ash (Class F)	2.1	-	-	-	Dirk India Pvt. Ltd , Nashik, Maharashtra
Micro Silica	2.2	-	-	-	-
Super Plasticizer	1.1	-	Glenium B233' (Pilycarboxylic ether Polymer)	-	BASF Chemical Company Ltd. Mumbai.

Table 1: Properties of material used in making HPC mixes.

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3. Experimental Programme:

The Experimental Program was designed to compare the Workability properties and mechanical properties of High Performance Concrete with M60 grade of concrete with different replacement levels of ordinary Portland cement 53 grade with Fly Ash and Micro Silica. The replacement levels of cement by Fly ash and Micro Silica are selected as 5%, 10%, 15%, 20%, and 25% .The specimens of Cube specimens of size 150 x 150 x 150 mm, prepared with and without silica fume.

4. Mix Design of HPC:

The mix design of HPC was made using the guidelines of IS Code method (IS 10262-2009). The design stipulations and the data considered in mix design of HPC has been presented below
Characteristics Strength, fck (Mpa): 60 Mpa.
Max. Size of course aggregate : 20mm (Crushed)
[Fraction-60%, 20mm. -12.5mm]
[FractionII-40% 12.5mm-10mm]
Degree of quality Control : Good
Type of Exposure : Severe
Degree of Workability : 100mm (Slump)
Target Mean Strength (fck), Mpa:

$$fck + t \times S = Fck + 1.65 \times S = 60 + 1.65 \times 5 = 68.25 \text{ N.mm}^2$$

Where,
Fck= characteristic compressive strength at 28 days.
S = standard deviation
T = a statistic, depending upon the accepted proportion of low results and the number of tests; for a large number of tests, the value of 't' is given in Table 2 of IS 10262-1982 code.

4.1. Mix Proportions:

Mix proportions of M60 grade HPC mix were obtained by making certain modifications in mix proportions arrived at using the guidelines of IS code method. The mix proportion was obtained without considering any addition or replacement of mineral admixtures (i.e. Fly Ash, Micro Silica).

After several trials, a cement content of 475 Kg/m^3 and water binder ratio of 0.3 was finalized based on 28 days compressive strength gain of HPC mix and desired workability properties (Slump, Flow and Compaction test). The final mix proportion was arrived at by altering the ratios of fine aggregate to course aggregate and is expressed as part water: cement: fine aggregate: coarse aggregate: Super Plasticizer as is given by
1). IS Code - 0.31:1:1.3:2.70:0.79 (Water: Cement: Fine Aggregate: Coarse Aggregate: Super Plasticizer)

4.2. Preparation of HPC Mix:

The required quantities of all the ingredients were taken by weight batching, with appropriate coarse aggregate fractions and mineral admixtures. Mixing of the ingredients was done in pan mixer as per standard procedure. A reference mix was prepared using a water/binder ratio of 0.31 and suitable super plasticizer content (by weight of cement) in order to get desired workability.

The workability of the concrete was studied by conducting slump, flow and compaction factor test as per the standard procedure (IS: 1199-1959.). Standard cube specimens of 150mmx150mmx150mm size were cast using the procedure described in IS code (IS: 516-1959) and were immediately covered with plastic sheet and kept there for 24 hours and then released in water tank for 28 days curing.
All the HPC mixes were prepared using the same mix proportion, water/binder ratio and super plasticizer dose and considered for the study of workability, strength properties of HPC mixes. The percentage of fly ash and micro silica varied by 5%, 10%, 15%, 20% and 25% by replacing weight of cement. Table given below shows workability properties of M60 Grade (IS code method) concrete as per variation of fly ash and micro silica.

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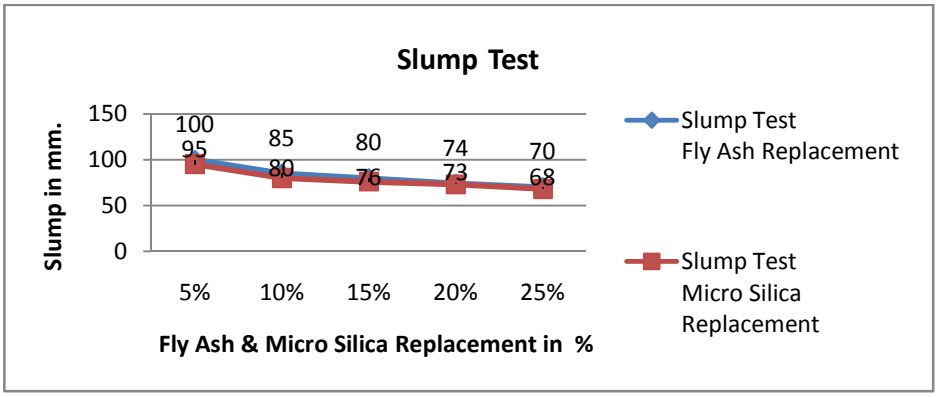
Sr. No.	Replacement Level	Slump Test Fly Ash Replacement (In mm.)	Slump Test Micro Silica Replacement (In mm.)
		IS Code	IS Code
1	5%	100	95
2	10%	85	80
3	15%	80	76
4	20%	74	73
5	25%	70	68

Table 2. Slump Test



Sr. No.	Replacement Level	Flow Test Fly Ash Replacement (In cm.)	Flow Test Micro Silica Replacement (In cm.)
		IS Code	IS Code
1	5%	26.66	28.91
2	10%	31.00	27.16
3	15%	29.00	26.33
4	20%	27.33	25.66
5	25%	25.66	25.33

Table 3. Flow Test

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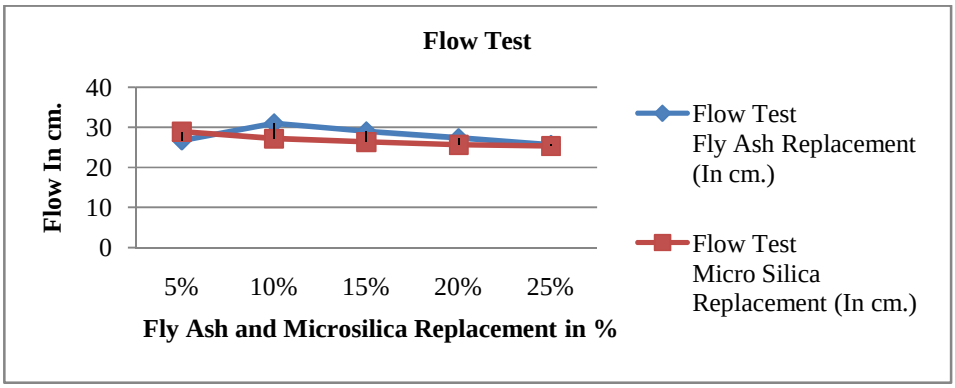

Flow Test

Casting Of Concrete Cubes

Slump Test

4.3. Testing Specimen:

After the 28 day curing period, the specimens were taken outside the curing tank and were tested under a compressive testing machine of 2000KN capacity for compressive strength. The crushing loads were noted and the average compressive strength of three specimens is determined. The compressive strength value of specimens subjected to different replacement level with Fly ash and Micro Silica has been presented in Table 4.

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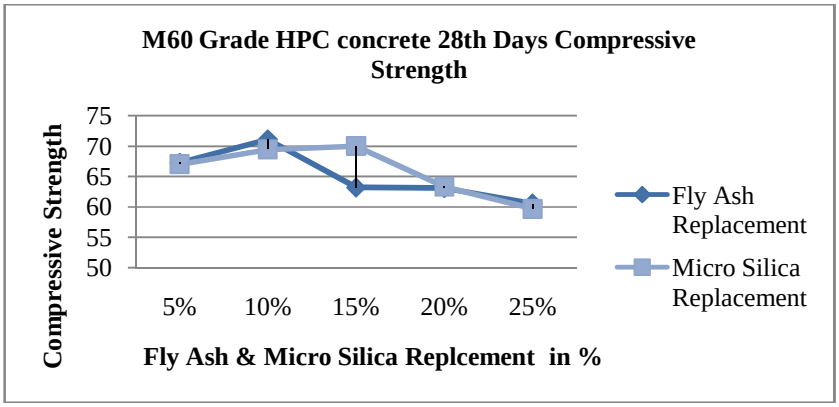
Sr. No.	Replacement Level In %	IS code Method	
		Compressive Strength M60 Grade Concrete (28^{th} days) N/mm^2	
		Fly Ash Replacement	Micro Silica Replacement
1.	5%	67.27	67.05
2.	10%	71.12	69.46
3.	15%	63.195	70.02
4.	20%	63.115	63.34
5.	25%	60.55	59.72

Table 4. Compressive Strength (28^{th} Days)



5. RESULT AND DISCUSSION:

Replacement of cement by Fly ash showed in M60 grade concrete compressive strength improvement up to the replacement of 10%. Fly ash level of 15% to 25 % showed reduction in compressive strength (28^{th} days). There is a decrease in workability as the replacement level increases, and hence water consumption will be more for higher replacements. The maximum replacement level of silica fume is 15% for M60 grade concrete.

6. CONCLUSION:

1] There is a decrease in workability as the replacement level of Fly Ash and Micro Silica increases, and hence water consumption will be more for higher replacements.
2] The maximum replacement level of Fly Ash is 10% and of Micro Silica is 15% for M60 grade High Performance Concrete.
3] It is concluded that maximum workability and compressive strength is achieved when 10% Fly Ash and 15% Micro Silica is added. The concrete is becoming stiffer as the percentage of Fly Ash beyond 10% and 15% of micro Silica is added.

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