State-of-art review on Study of high performance concrete containing supplementary cementitious materials

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ABSTRACT: *The aim of this research was to study the performance of high performance concrete (HPC) Containing supplementary Cementitious materials. In the last millennium concrete had demanding requirements both in terms of technical performance and economy and yet greatly varied from architectural masterpieces to the simplest of utilities. Concrete had a good future and is unlikely to get replaced by any other material on account of its ease to produce, infinite variability, uniformity, durability and economy. Materials such as Flyash, Alccofine , Microsillica , Slag, etc.By using these materials we can reduce the cost without losing the strength, if proper proportions are taken.*

Keywords- **cementitious materials, alccofine ,flyash ,microsillica**

I. INTRODUCTION

High performance concrete are used extensively throughout the world where oil, gas, nuclear, high rise building and power industries are among users. The applications of such concrete are increasing day by day due to their superior structural performance, environmental friendliness, and energy conserving implication. The search for alternative binders, cement replacement material, has been carried out for decades. Research has been conducted on the use of fly ash, volcanic pumice, pulverized-fuel ash, blast slag and silica fume and micro silica as cement replacement material. These materials can also improve the durability of concrete and the rate of gain in strength and can also reduce the rate of the liberation of heat, which is beneficial for mass concrete. Concrete containing mineral admixture are used extensively throughout the world for their good performance and for ecological and economic reasons.

II. NEED OF HPC

HPC is required as a construction material in structures constructed in very several environments. The structures like tunnels in sea beds, tunnels and pipes carrying sewage, Offshore piers and platforms, confinements structures for solid and liquid wastes containing toxic chemicals and radioactive elements, jetties and ports, sea link bridges pier and superstructures and high rise structures, chimney and towers, foundations and piles in aggressive environment. Concrete has performed reasonably well in the past in favorable environment, if design and constructed properly. Concrete strength, which is easily regulated by controlling the water-cement ratio, has served well in the past as the principal criterion for performance of ordinary concrete.

III. ADVANTAGES OF HPC

- Reduction in member size, resulting in increase in plinth area/useable area and direct savings in the concrete volume saved.
- Reduction in the self-weight and super-imposed DL with the accompanying saving due to smaller foundations.

- Longer spans and fewer beams for the same magnitude of loading.
- Reduced axial shortening of compression supporting members.
- Reduction in the number of supports and the supporting foundations due to the increase in spans.
- Reduction in the thickness of floor slabs and supporting beam sections which are a major component of the weight and cost of the majority of structures.
- Superior long-term service performance under static, dynamic and fatigue loading.
- Low creep and shrinkage.

IV. LITERATURE REVIEW

1). USE OF ALCCOFINE FOR HIGH PERFORMANCE CONCRETE
(Ambuja cements ltd, Alcon developers)

ALLCOFINE performs in superior manner than all other mineral admixtures used in India. Due to high CaO content, ALCCOFINE 1203 triggers two way reaction during hydration – Pozzalonnic and hydraulic reaction. This results in denser pore structure and higher strength gain.

Following are the chemical properties of Alccofine and others mineral admixture.

Table no. 1.1

Chemical Composition	OPC	GGBS ALCCOFINE 1203	FA	SF	MK	RHA
CaO	64%	34%	3%	<1%	<1%	*
SiO2	22%	35%	55%	>90%	52%	90%
Al2O3	8%	24%	25%	*	45%	*
Others	Balance	Balance	Balance	Balance	Balance	Balance

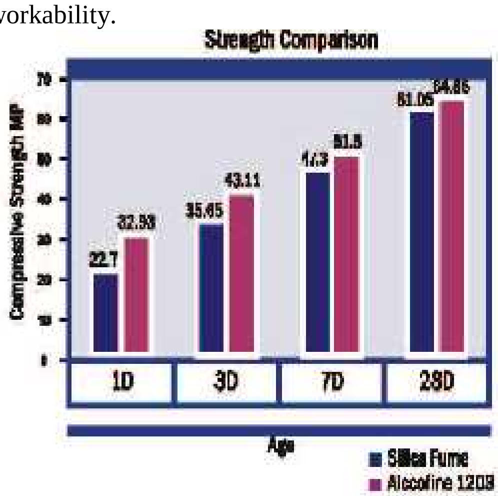
Following is the properties of Alccofine

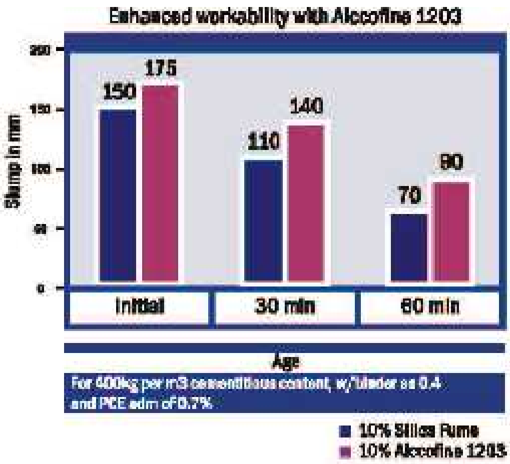
Strength

Alccofine 1203 results in to formation of dense pore structure and inbuilt CaO provides increased secondary hydrated product because of which improved strength gain at early as well as later ages observed.

Workability & Cohesiveness

Alccofine 1203 have better particle size distribution compared to other Supplementary Cementitious Materials which provides dense matrix pore structure resulting in to reduced water contains and batter workability.





Lower the heat of hydration

Alccofine 1203 has the lime contain 34% which provides more quantum of secondary hydrated product. This results in prolonged chemical reaction and responsible for reduced heat liberated by the hydration process.

Flow ability

Alccofine 1203 has batter particle packing which results in to increased rheology resulting in to improved flow ability.

2). “Utilisation of flyash as cement replacement material to produce high performance concrete”

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Disposal of fly ash, a waste product from thermal power plants, is a major problem in India. Many R&D and academic institutions are actively involved in the effective utilisation of Flvash in Civil Engineering applications. The Structural Engineering Research Centre (SERC), Chennai has carried out extensive research on utilisation of fly ash in concrete as partial cement replacement material (CRM) since 1975 . Recently, SERC has carried out extensive R&D work on development of High Performance Concrete (HPC) mixes using flyash(FA), ground granulated blast furnace slag(GGBS) and silica fume(SF) as mineral admixtures, especially to improve the durability characteristics of cement concrete. This paper presents the mechanical and durability properties of different HPC mixes containing fly ash. HPCs using flyash as mineral admixture have been used to develop precast concrete products such as, non-pressure pipes and heavy duty paver blocks and these developments are reported in this paper.

The compressive strength at 7,28 and 90 days of all the 5 series of mixes are tabulated
in Table 6 . It is observed that the compressive strength at 7 days for mixes containing0, 15, 20, 25 and 30% cement replacements were 63 . 2, 56.5 , 53.2, 49. 2 and 48.9 MPa, respectively. The strengths at 28 days were 83.5, 89.5, 87.5, 85.2 and 75.2, respectively.

The strengths at 90 days were 93.7, 94.0, 95.0, 94.0 and 86.0, respectively. Thus, it can be seen that by the addition of flyash, the strength at 7 days (Table 6) of the FA based HPCs has marginally decreased where as the strength at 28 days was observed to be slightly greater than that of the reference HPC mix. The decrease in strength at 7 days for the FA based HPCs varies from 10 to 23% for cement levels with FA of 15 to 30% when compared with the strength at 7 days of control mix having no CRM. However, the strengths at 90 days tend to be the same for replacement levels up to 25%. The reduction in the strength at 7 days may be attributed to reduction in the cement content, slower pozzolanic reaction at early ages and increase in the water-cement ratio. However, at the age of 28 days, the increase in pozzolanic activity was sufficient to contribute to the compressive strength. Thus, the efficiency of flyash to act as cementitious material has increased substantially at 28 days and the strength development continues beyond 28 days and stabilises towards 90 days. Beyond 28 days, the FA- HPCs have marginally higher strength than HPC without flyash. This demonstrates that the replacement of cement by flyash even up to 30% for compressive strength of 80 MPa at 28 days is possible without loss of strength and resulting in saving in consumption of cement.

MIX	CRM%	7D	28D	90D
C1	0	63.2	83.5	93.7
C2	15	56.5	89.5	94
C3	20	53.2	87.4	95
C4	25	49.5	85.2	94
C5	30	48.5	75.2	86

3) “Experimental Studies on High Strength Micro Silica Concrete”-By Ravindra S. R., Mattur C. Narsimhan (2003), ICI Journal, July-Sept : Vol.: 4, No.: 2

In the present investigation an attempt has been made to study the performance characteristics of a few Silica Fume Admixed Concrete (SFC) mixes. The study aims to investigate the effect of increasing the percentage replacement of cement with Silica Fume in the SFC mixes on their strength properties and water absorption characteristics. The mixes tested herein have been admixed with appropriate superplactisizer with a dosage of 2.5% so as to make them workable. The grade of concrete M40 was adopted for the studies.

Compressive strength, split tensile strength & flexural strength was observed during investigations. The max compressive strength was observed at 11.5% SF cement replacement level. The increment about 28% of tensile strength was reported & flexural strength was about 14% compared to normal mix.

4) “Investigations on the Tensile Strength of High Performance Concrete Incorporating Silica Fume” By Santanu Bhanj & Bratish Sengupta

Though the literature is rich in reporting on silica fume concrete the technical data on tensile strength is quite limited. The present paper is directed towards developing a better understanding on the isolated contribution of silica fume on the tensile strengths of High Performance Concrete.

Extensive experimentation was carried out over water-binder ratios ranging from 0.26 to 0.42 and silica fume binder ratios from 0.0 to 0.3. For all the mixes compressive, flexural and split tensile strengths were determined at 28 days.

The results of the present investigation indicate that other mix design parameters remaining constant, silica fume incorporation in concrete results in significant improvements in the tensile strengths of concrete along with the compressive strengths.

5) “An Experimental investigation on micro silica concrete with fly ash on concrete strength behavior” NCRASE” By Reddy B.D, Reddy G.B. (2006).

In this paper an experimental investigation carried out in the laboratory parameter considered for this investigation are the replacement of cement by micro silica with proportioning ranging from 2% to 8%with an equal increment of 2% and the replacement of cement by fly ash ranging from 4% to 12% with an equal increment 4%at constant water/cementitious material ratio is 0.45.

The basic properties of silica fume and fly ash are tested .The specific gravity of silica fume is 2.01 and specific gravity of fly ash is 2.4.From the result of compressive strength test at constant fly ash percentages of 4%,8%,and12% are observed that at constant 4% flyash content, the compressive strength is minimum at 6% SF and maximum at 8%SF.

CONCLUSION:

I. Very good scope of study for using ALCCOFINE in high performance concrete To Obtain Better Workability Than Conventional Concrete With Fly Ash Using Optimum Percentage Of Admixtures.
II. To obtain long Durability As well As Strength by Using Proper Proportion of Fly Ash.
III. Since concrete mixes having fly ash as CRM have lesser cement content, adverse effects related to higher cement content, such as shrinkage, excessive rate of heat development etc., are minimized in the concrete.
IV. Mixes having fly ash as CRM are found to be more durable and corrosion resistant due to their refined pore size distribution, as seen from lower sorptivity and reduced chloride diffusion coefficient obtained in this study. Reinforced concrete structures and precast products made with concrete having flyash as CRM would, therefore have long, maintenance-free service life.
V. The optimum 28-day split tensile strength has been obtained in the range of 5-10 % silica fume replacement level whereas the value for flexural strength ranged from 15-25 %.
VI. Both the split and flexural tensile strengths at 28 days follow almost the same trend as the 28-day compressive strength. Increase in split tensile strength beyond 15 % silica fume replacement is almost insignificant whereas sizeable gains in flexural tensile strength have occurred even up to 25 % replacements.
VII. By using such materials we can minimize the content of cement and replace these materials (Microsillica, Alccofine, Flyash) for making mix design economical and also ecological without losing the strength.

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