Influence of Supplementary Cementitious Materials on High Strength Concrete

Ashish Banjare[1] Dr. S. K. Jaiswal[2]
[1,2]Department of Civil Engineering
[1,2]Bhilai Institute of Technology Durg, India

Abstract— This thesis explain the steps which taken to develop High Strength concrete (HSC) mixes with supplementary cementious material. For the High Strength concrete mixes with the Fly ash, Metakaolin, Silica Fume and combination of these, the fulfillment of the flow and cohesiveness criteria are found to be sufficient for the mix design.

Key words: High Strength Concrete (HSC), Supplementary Cementitious Materials

I. INTRODUCTION

Supplementary cementitious materials (SCMs) are finely ground solid materials that are used to replace part of the cement in a concrete mixture. These materials react chemically with hydrating cement to form a modified paste microstructure. In addition to their positive environmental impact, SCMs may improve concrete workability, mechanical properties, and durability. Industrial by-products are more commonly used today. Fly ash (FA), the most extensively used SCM, is the inorganic, non combustible residue of powdered coal after burning in power plants. Silica fume (SF) is harvested from the effluent gases produced in the manufacture of silicon metal and alloys. Metakaolin (MK) is unique in that it is not the by-product of an industrial process nor is it entirely natural.

II. HIGH PERFORMANCE CONCRETE

High performance concrete is a concrete mixture, which possesses high durability and high strength when compared to normal concrete. Any concrete which satisfies certain criteria proposed to overwhelmed limitations of conventional concretes may be called High Performance Concrete.

It should satisfy one of the following strength criteria:

- 4 hour strength ≥17.5 Mpa
- 24 hour strength ≥35.0 Mpa
- 28 days strength ≥ 70.0 Mpa
- It should have a durability factor greater than 80% after 300 cycles of freezing and thawing.
- It should have a water-cement ratio of 0.35 or less.

III. MATERIALS AND METHODOLOGY

A. Cement

Ordinary Portland Cement (OPC), 43 grades conforming to IS: 12269-1987 was used.

B. Aggregates

Crushed granite rock 20 mm and downsize and river sand were used as coarse and fine aggregates. The fineness modulus is 3.12 and 7.19 for fine and coarse aggregate, respectively. The specific gravity of fine and coarse aggregates are 2.62 and 2.74.

C. Water

Potable water was used for mixing and curing of concrete specimens.

D. SCM

1) FA:

Class C Fly ash obtained from ―Monnet Ispat Raipur India is used.

2) SF:

SF used in the study was obtained from obtained from Guru Corporation Ahmadabad

3) Metakaolin (MK):

The MK was obtained from M/s. 20 Microns Limited, Baroda, India.

E. Chemical Admixture

Parex binder is an aqueous crystal which has to dissolve in plane water @1:2 ratio (1kg parex binder and 2 liter plain water). Perex binder manufactured under controlled condition to produce a consistent product which ensures uniform and predictable performance when used. the dosage of superplasticizer is suitably adjusted based on trials to get the desired workability.

F. Mix Proportion

In this work, the mix proportion for HPC mix of M40 The mix proportions are presented in 4.3. The cube specimens after de-mol ding were stored in curing tanks, and on removal of cubes from water, the compressive strength was conducted at 7and 28 days. The test results were compared with individual percentage replacements (Binary mix) and combinations of admixtures (Ternary mix) for M40 Mix.

G. Compressive strength test (IS: 516 – 1959)

The testing machine shall be equipped with two steel bearing platens with hardened faces Tests shall be made at recognized ages of the test specimens, the most usual being 7 and 28 days. The ages shall be calculated from the time of the addition of water of the dry ingredients. At least three specimens, preferably from different batches, shall be made for testing at each selected age the measured compressive strength of the specimen shall be calculated by dividing the maximum load applied to the specimen during the test by the cross sectional area, calculated from the mean dimensions of the section and shall be expressed to the nearest Kg/cm2..

IV. RESULTS AND DISCUSSIONS

Before conducting the compressive strength tests on concrete cubes after 7days and 28days for finding out the durability properties, The effect of SCMs on partial replacement of cement concrete (M40) with superplasticizer is presented,

Grade of concrete	Cement	SCM	Fine aggregate	Coarse aggregate	Water
M40	400	120	660	1168	160

Table 1: Mix proportion for M40 grade of concrete in kg/m^3
SCMs=Supplementary cementing materials

A. Compressive Strength N/mm^2

1) Binary Mix:

Mix	Compressive strength (N/mm2)	
	7 days	28days
FA0%	38.4	48.5
FA20%	39.6	49.9
FA25%	40.8	52.5
FA30%	41.2	56.7
FA35%	36.4	40.5

Table 2: Compressive strength of Fly Ash HSC mixes

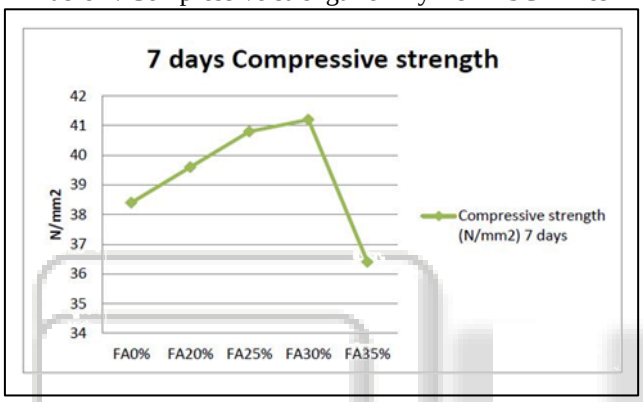

Fig. 1: Compressive strength in 7 days of Fly Ash HSC mixes

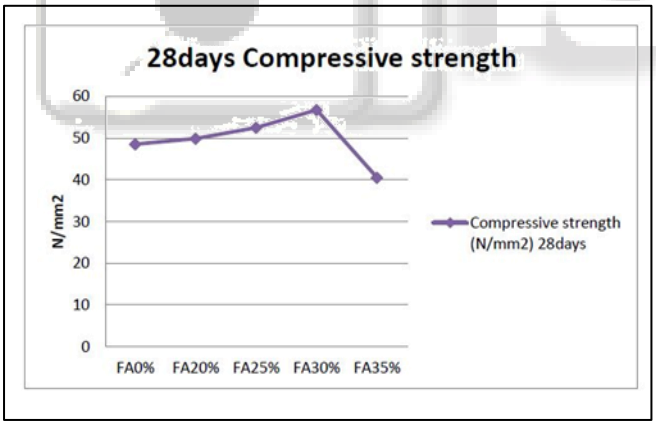

Fig. 2: Compressive strength in 28 days of Fly Ash HSC mixes

2) Ternary Mix:

	Compressive strength (N/mm2)	
MIX	7 days	28days
SFFA (0%;0%)	38.4	48.5
SFFA1 (8%:20%)	43.14	53.54
SFFA2 (8%:25%)	45.77	56.87
SFFA3 (8%:30%)	46.8	59.4
SFFA4 (8%:35%)	35.57	42.87

Table 3: Compressive strength of HSC mixes with Silica Fume and FA

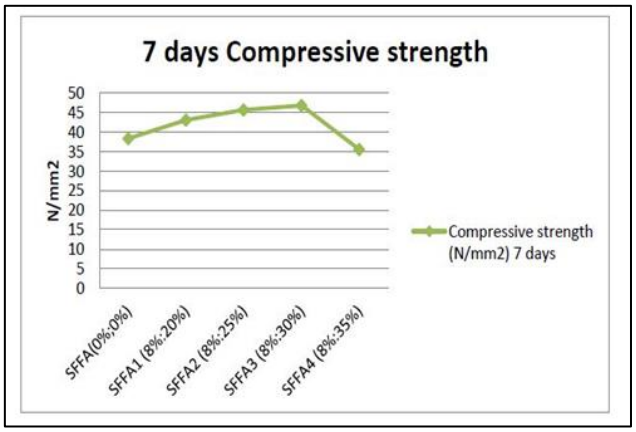

Fig. 3: Compressive strength in 7 days of FA and SF HSC mixes

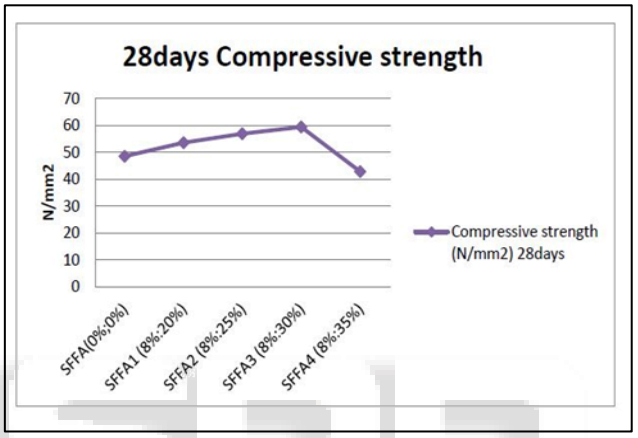

Fig. 4: Compressive strength in 28 days of FA and Silica fume HSC mixes

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