Experimental Investigations on M80 Grade Concrete Using Supplementary Cementitious Materials

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***Abstract*-It is aimed to study about the performance of M 80 grade multi blended cement mixes with supplementary cementitious materials like Flyash(FA), Silica fume(SF) and Metakaolin(MK) to produce High performance concrete mixes. In this present investigation, an attempt of understanding the result acquired for High performance multi blended concrete mixes compared with results of ordinary Portland cement concrete mixes(OPC) were made. The multi blended high performance concrete mixes investigated are the combinations of *5%,10%* and *15%* of partial replacement of FA,SF,MK individually and the combinations as *15%*FA + *10%*SF, *15%*FA + *10%*MK and also *10%*FA+*7.5%*SF+*7.5%*MK by the weight of the cement with a constant 0.3 water binder ratio.The M_{80} grade concrete strength is evaluated by Compressive and Tensile Strength tests determining at *3,7,28* days. The steel fibers and super plasticizer were also added to achieve greater strength and the required degree of workability for all the mixes prepared. It is observed that the multi blended M80 grade concrete exhibited greater compressive strength than that of OPC mixes and also a good performance of strength development in a short period of time, which were discussed in this paper.**

***Keywords*-Multi blended, Supplementary cementitious, Flyash(FA), Silica fume(SF), Metakaolin (Mk), High performance, Ordinary Portland cement(OPC), Compressive strength, Tensile strength.**

I. INTRODUCTION

A concrete mixture that meets certain characteristics which are developed for a specific environment that possess high durability, high strength and high workability with the additives added like chemical and mineral admixtures and that the concrete is designed to exceed the performance of the ordinary concrete is known as "High performance concrete." Present day concrete requires improved compressive strength, high tensile strength, reduced porosity and very high durability. Flyash, Silica fume, Metakaolin are the Supplementary cementitious materials mostly used in high performance concrete's produced today that are used separately or in combinations as that of in this study.Increasing demands on concrete require the need to develop the properties of concrete resulting in the preparation of HPC.Thus high strength concrete is considered as the relativecombinations of new materials under development in the properties. Since few years the concrete of high strength entered the field of construction, in particular of high-rise buildings constraint and long span bridges with their utilization as increased. As per IS 456-2000, compressive strength of over 110 MPa can be considered for the applications in cast-in-place buildings and pre-stressed concrete members whereas a plain concrete possesses a very low tensile strength, limited ductility and little resistance to cracking with further propagation of internal micro cracks due to poor tensile strength eventually leading to brittle fracture of the concrete. It has been recognized that the addition of small, closely spaced and uniformly dispersed fibers to the concrete would act as crack arrester and would substantially improve its compressive and flexural strength properties and this type of concrete is known as fiber reinforced concrete.

II. OBJECTIVE AND SIGNIFICANCE

The main objective of the present study is to develop a HPC by varying mix proportions of replacement materials of concrete at a constant super plasticizer dosage and following the IS code provisions and method of mix design. There are investigations carried out for M80 grade concrete to produce HPC mixes using supplementary cementitious materials to obtain good workability of the designed mixes.

III. EXPERIMENTAL PROCESS

A. *Mix proportion*-In this present study Flyash, Silica Fume, and Metakaolin are used at various proportions of 5%, 10%, and 15% of partial replacement individually and then in combinations of 15% FA + 10%SF, 15% FA + 10%MK and also 10%FA + 7.5% SF + 7.5%MK by the weight of the cement with a constant 0.3 water binder ratio as cementitious materials along with addition of steel fibers, obtaining finishability with mixes containing silica fume often requires super plasticizers and high-range water-reducing admixtures (HRWRA) are used here.

B. *Materials Used*- Ordinary Portland cement conforming to IS 12269-1987 was used in the program. The 53 grade specific gravity of cement was 3.15.

Crushed stone aggregate with combination of 20mm of 60% and 12mm of 40% from local source with 2.74, specific gravity confirming to IS 383-1970 are used.

Locally available river sand passing through 4.75 sieves, confirming to IS 383-1970 with 2.74, specific gravity is used.

C. *Admixture used-* ***Poly Carboxylic Ether*** with a specific gravity of 1.02 and is brown in colour at a recommended dosage of 0.015lit of Varaplast PC 100 per 1Kg of cement is used for effective workability.

Flyash Produced by ULTRA TECH CEMENT in Nellore in the form of dry powder and that satisfies all the requirements of IS:3812-1981, is used in this study.

Silica fume with specific gravity of 2.22 is used. This is increasingly used supplementary cementing material for concrete known as Silica dust or micro silica or volcanized silica usually grey or premium white color.

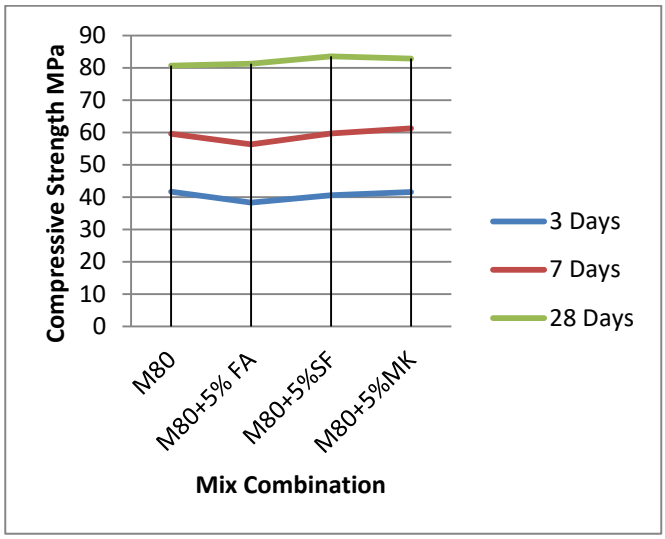
Metakaolin with specific gravity of 2.6 is used in concrete to reduce cement consumption to increase strength and rate of strength gain to decrease permeability and improve ductility and reduce the porosity of concrete.

High tensile Steel fibers of crimped type were used with a volume fraction of 0.5% with respective to 100%.

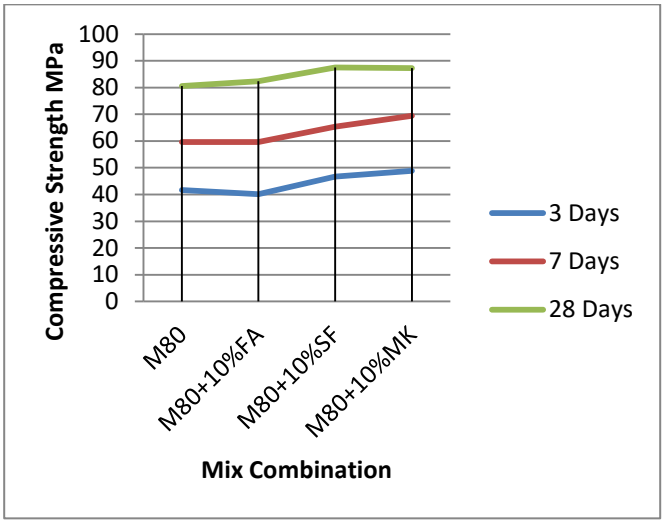
Each supplementary material is used at various replacement ratios as 5%, 10% and 15% weight of the cement.

IV. RESULTS AND DISCUSSIONS

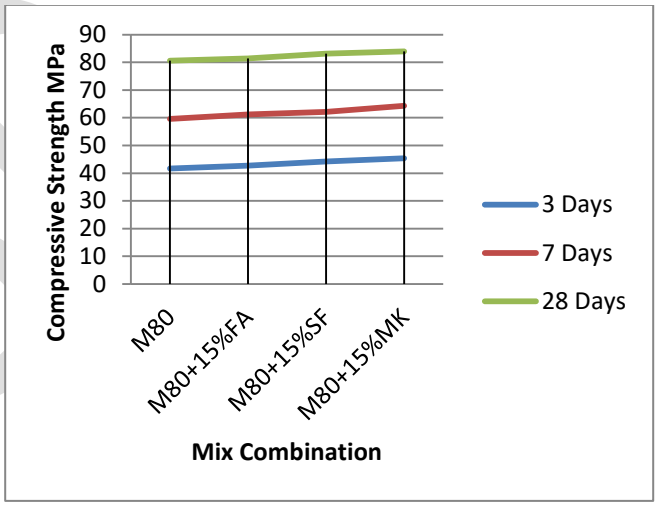
Thetests conducted in the present study for both concrete cubes and cylinders of various mix proportions designed for the investigation on the performance of them to obtain High strength concrete compared with the individual replacement percentagesand with different combinations of admixtures of designed M80 grade concrete and results obtained for compressive strength, tensile strength of these are presented in the graphs. It is observed that both the compressive strengthand tensile strengthis increased in HPC mixes due to the addition of Admixtures and steel fibers.



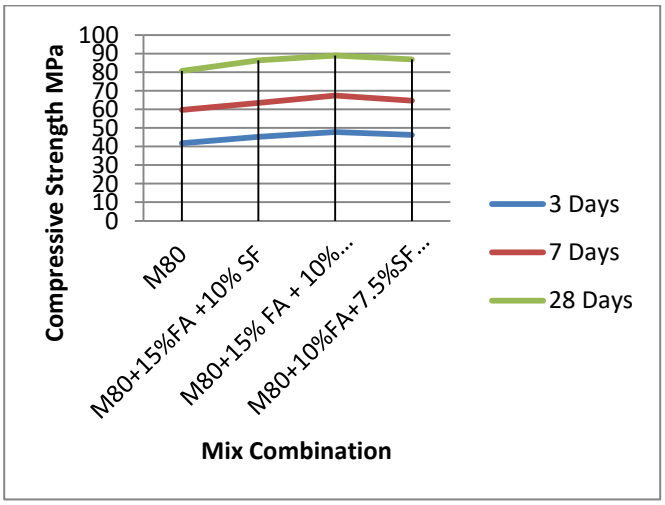
Graph 1: Compressive Strength results at 5% admixtures



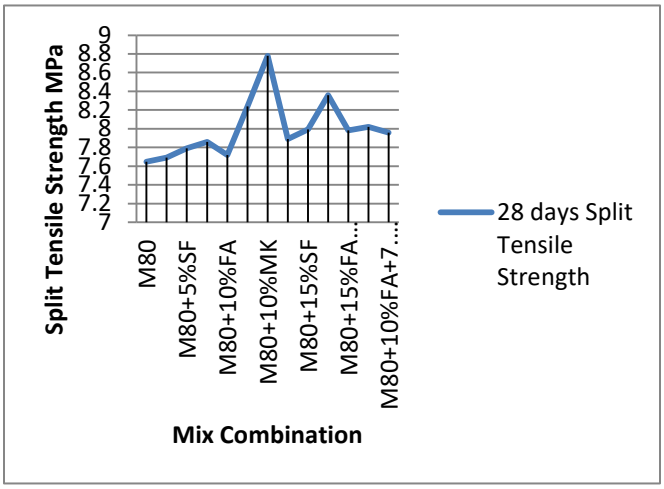
Graph2: Compressive Strength results at 10% admixtures



Graph3: Compressive Strength results at 15% admixtures



Graph 4: Compressive Strength results with combinations of admixtures



Graph 5: Split Tensile Strength results with admixtures

V. CONCLUSIONS

1) The water cement ratio is adopted low in high performance concrete mix hencesuper plasticizers are required for workability.
2) The maximum compressive strength achieved for M80 grade concrete is 88.8MPa with the mineral admixtures replacement combinations of 15% Flyash and 10% of Metakaolin.
3) The percentage replacement of mineral admixtures such as Flyash, Silica fume and Metakaolin contribute for achieving high strength along with the steel fibers effectively.
4) The maximum compressive strength and split tensile strength for Flyashis 82.3MPa and 7.89MPa respectively.
5) The maximum compressive strength and Split tensile strength for Silica Fume is 87.54MPa and 8.24MPa respectively.
6) The maximum compressive strength and Split tensile strength for Metakaolin is 87.21MPa and 8.78MPa respectively.
7) In the combination replacement of 15% Flyash and 10% Metakaolin admixtures, the maximum compressive strength achieved in M80 grade concrete is 88.8MPa.
8) It is also observed that the high strength concrete cubes tend to fail suddenly with the appearance of micro cracks.
9) There is a large scope of using the high strength concrete in constructional activities like precast, multi-storied buildings, bridges and coastal areas.
10) It is also observed that the workability decreases with increased percentage addition of Silica Fume and Metakaolin and workability increases with addition of Flyash.
11) There's an optimum compressive strength observed upto the 10% replacement of admixtures and strength decreases beyond 10% of SF, MK whereas addition of 15% Flyash increases the compressive strength.
12) The cost of Silica Fume is approximately 3times of Metakaolin. By this we can understand that, a world class concrete can be produced by using locally available materials at affordable prices.

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