EFFECT OF COMPOSITE FIBERS ON FLEXURAL STRENGTH OF HIGH PERFORMANCE CONCRETE

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Abstract : Concrete industry provides an ideal method to utilize a number of waste materials. Presence of such materials in cement concrete improves workability and durability. This paper presents the details of an experimental investigation carried out to use Fly Ash, Metakaolin, and Silica fume as a partial replacement to cement along with Steel Fibres and Polypropylene fibers in concrete in an attempt to investigate the flexural strength of High-Performance Concrete. Absolute volume method is used for the mix design. Three different replacement levels of Mineral admixtures namely 0%, 5% and 10% each are chosen for the study along with 0.5% and 0.75% of Steel fibers and 0.25% of Polypropylene fibers in the production of High-Performance Concrete. Beams of 100 x 100 x 500 mm were cast, cured for 28 days and then tested to record the flexural strengths to compare with the reference mix. The results have been analyzed and useful conclusions have been drawn.

***IndexTerms* - Flyash, Metakaolin, Silicafume, Steel Fibres, Polypropelene fibres**

I. INTRODUCTION

According to the IS 456:2000 there are 3 groups of concrete based on different grades and they are classified as Ordinary concrete (grades from M10 to M20), Standard concrete (grades from M25 to M60), High strength concrete (grades from M65 to M100) Further under Note 2, code additionally mentions that for concrete of compressive strength better than M60, the design of concrete parameter provided in the standard may well not be appropriate and the values might be received from the specialised literature as well as experimental results. It's thus required to use the assistance from standard published works as well as experimental outcomes in the layout and creation of High Strength Concrete.

Concrete is actually identified as "high strength" exclusively on the foundation of compressive strength at a specified age but while in 2002 ACI Committee modified the meaning of higher strength concrete as the coverage of mixtures with a certain design strength of 55Mpa or over. Although the high strength concrete includes increased toughness it has its own limitations. It is generally perceived as a concrete with a minimal use such as the building of columns in high rise structures, offshore platforms. Nevertheless, high strength concrete is preliminarily used in critical parts of the structure and largely under ambitious environmental conditions. Through the years, it's been experienced that apart from the potential specifications of strength only, concrete in such scenarios must also be brought under the ambit of ideal performance. Therefore, the idea of "High-performance concrete" emerged in 1991. The phrase was very first, coined by professor Roger Lacroix as well as Professor Yves Malier. Today high-performance concrete is waived as an emerging kind of concrete whose applications are actually rising both in volume and in the assortment. In truth, high strength concrete has now turned into a synonym for high-performance concrete.

It is actually the concrete which changes the time durability of the structure exposed to the intense environment. In 1998, America concrete institute redefined High-performance concrete as "The concrete meeting special amalgamation of performance and uniformity requirements which can't be regularly attained by routinely using standard constituents and regular mixing, placing and curing methods". Generally, High-performance concrete could be known as a concrete prepared using apposite supplies pooled to offer performance that is excellent in certain attributes of concrete such as elevated density, elevated strength, good resistance and impermeability to prevailing environmental elements.

Abhijit Singh Parmar et al intended in reducing the expense of concrete by realizing the optimal dosage of fly ash and also alccofine which usually might be changed with the cement content material. They carried out a non-destructive examination of the concrete specimens to understand the compressive, flexural and split tensile strength of concrete. As a result of this particular experimental studies one can easily determine that the concrete had the outstanding quality, the primary strength was discovered to be 42.33 MPa as well as 66.64 MPa on 7th along with 28th day with a substitute of cement with fly ash by 22 % and also alccofine by 8%, later right after twenty eight days the gain in strength was diminished comparatively and also the cylinders had the utmost split tensile strength of 5.08 Mpa.

P. Dinakar et al with the aim of achieving a target strength of 90MPa as well as a slump of 100 plus or minus 25mm of concrete and it was created by changing the cement articles with the metakaolin combination. The primary goal was studying the physical and durability qualities of concrete that had been partly replaced with metakaolin always keeping the w/c ratio 0.3 constant. For the 10 % replacing with the metakaolin the compressive toughness was discovered to be 106 MPa. From the outcomes, they concluded that until 10 % replacement the compressive sturdiness of concrete was increasing beyond that the sturdiness of the concrete was decreased. splitting tensile strength as well as flexible modulus values have followed the identical phenomena, as well as the plastic density of the combination, was discovered to be with the cement replaced with the partial level of metakaolin.

II. Materials Used

The details of the various materials used in this investigation are given in the following sections.

2.1. Cement Used

Ordinary Portland cement of 43 grade of Ultratech brand conforming to IS: 12269 standards were used in this investigation. The specific gravity of the cement was 3.08. The initial and final setting times were found as 55 minutes and 210 minutes respectively.

2.2. Fine Aggregate Used

Fine aggregate which was collected in an around Ballari conforming IS 383-1970 passing 4.75 mm and with the specific gravity of 2.5.

2.3. Coarse-aggregate Used

Crushed granite aggregate available from local sources has been used. The specific gravity of coarse aggregate is 2.70.

2.4. Water Used

Potable fresh water available from local sources was used for mixing and curing of mixes.

2.5. Mineral Admixtures

Properties of Mineral Admixtures are as follows

Table 1: Specific gravity of Mineral Admixtures

SL.NO	Admixtures	Specific Gravity
1	Flyash	1.9
2	Metakaolin	2.6
3	Silica fume	2.3

III. Methodology

The main aim of the experimental program is to study the Flexural property of concrete. Cement is partially replaced with Flyash, Metakaolin, and Silica fume in the proportion of 0%(Reference mix), 5% and 10% by weight. Steel fibers in two percentages i.e 0.5% and 0.75% along with Polypropylene of constant 0.25% were used. The materials are weighed and dry mixed thoroughly after the measured amount of water for Water cement ratio of 0.3, 0.35 and 0.4 is added and the material is mixed thoroughly until it becomes uniform. Concrete produced are filled in 100mm× 100mm × 500mm moulds. After 24 hours of casting, the specimens are de-molded and kept for curing. The specimens were tested after 28 days of curing for flexural strength in accordance with Bureau of Indian Standards. For each trail, 3 beams were cast and tested at the age of 28 days. The average values of flexural strength were adopted in each case.

IV. Discussions of Test Results

4.1. Flexural strength for 0% of each admixture and for various percentages of Steel Fibres and Water Binder Ratio:

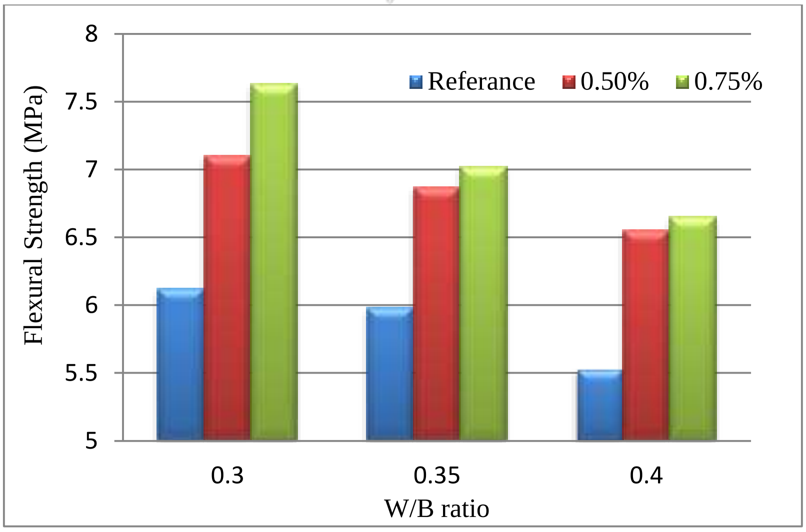

Fig.1 Flexural strength for 0% admixtures and for various percentages of Steel Fibres and Water Binder Ratio.

From this figure, it can be observed that the Flexural strength increases with the addition of Steel fibers. Maximum Flexural strength is obtained for concrete with W/B of 0.3 and for Steel Fibre percentage of 0.75%. Flexural strength is increased by 24.67% for this mix compared to Reference Mix. But it can also be observed that there is only 7.46% of strength increase when steel fiber is increased from 0.5% to 0.75% and is true for all ages of concrete and for all other mixes.

4.2. Flexural strength for 5% of each admixture and for various percentages of Steel Fibres and Water Binder Ratio:

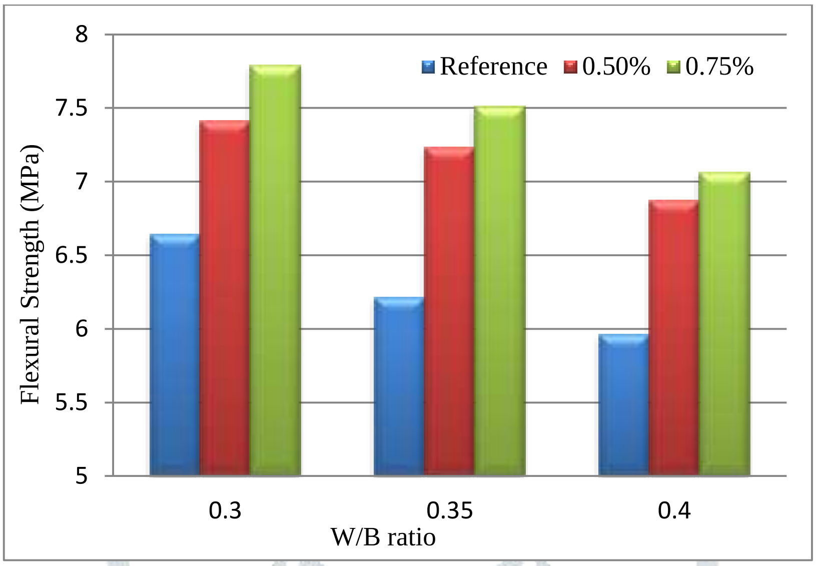

Fig.2 Flexural strength for 5% admixtures and for various percentages of Steel Fibres and Water Binder Ratio

From this figure, it can be observed that the Flexural strength increases with the addition of Steel fibers. Maximum Flexural strength is obtained for concrete with W/B of 0.3 and for Steel Fibre percentage of 0.75%. Flexural strength is increased by 17.31% for this mix compared to Reference Mix. But it can also be observed that there is only 5.12% of strength increase when steel fiber is increased from 0.5% to 0.75% and is true for all ages of concrete and for all other mixes.

4.3. Flexural strength for 10% of each admixture and for various percentages of Steel Fibres and Water Binder Ratio:

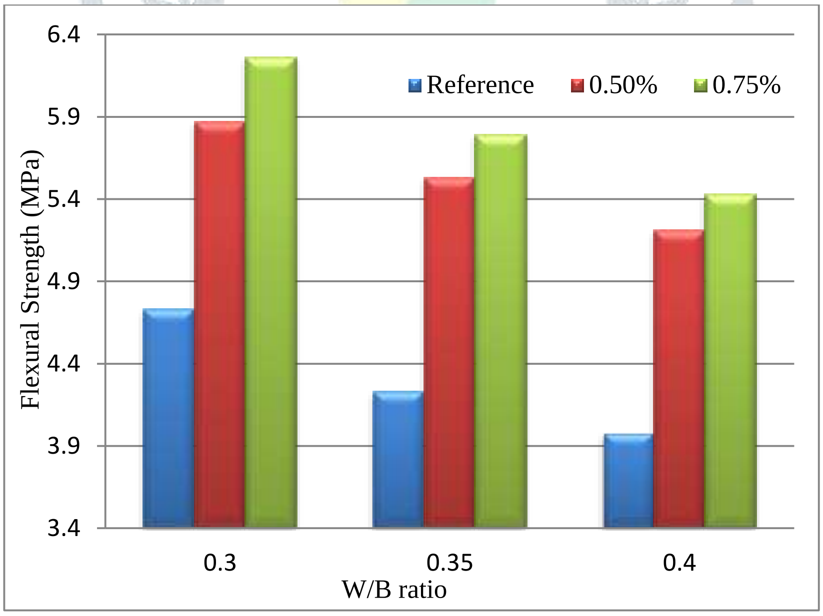

Fig.3 Flexural strength for 10% admixtures and for various percentages of Steel Fibres and Water Binder Ratio

From this figure, it can be observed that the Flexural strength increases with the addition of Steel fibers. Maximum Flexural strength is obtained for concrete with W/B of 0.3 and for Steel Fibre percentage of 0.75%. Flexural strength is increased by 32.55% for this mix compared to Reference Mix. But it can also be observed that there is only 6.81% of strength increase when steel fiber is increased from 0.5% to 0.75% and is true for all ages of concrete and for all other mixes.

V. Conclusions

The important conclusions of the present paper are summarized below.

1. Maximum Flexural strength is obtained for concrete with W/B of 0.3 and for Steel Fibre percentage of 0.75%. Flexural strength is increased by 24.67% for this mix compared to Reference Mix for 0% admixtures and for various percentages of Steel Fibres and Water Binder Ratio.
2. Maximum Flexural strength is obtained for concrete with W/B of 0.3 and for Steel Fibre percentage of 0.75%. Flexural strength is increased by 17.31% for this mix compared to Reference Mix for 5% admixtures and for various percentages of Steel Fibres and Water Binder Ratio.
3. Maximum Flexural strength is obtained for concrete with W/B of 0.3 and for Steel Fibre percentage of 0.75%. Flexural strength is increased by 32.55% for this mix compared to Reference Mix for 10% admixtures and for various percentages of Steel Fibres and Water Binder Ratio.
4. Flexural strength increases with an increase in 5% of each admixture from 0%, but with an additional increase of 5%, the Flexural strength decreases. Thus we can conclude that a 5% addition of each admixture and Water Binder ratio of 0.3 is optimum to obtain maximum Flexural strength.

References

[1] Adel A. Al-Azzawi, Ahmed Sultan Ali and Husam K Risan, Behavior of Ultra High Performance Concrete Structures: ARPN Journal of Enginnering and Applied Science, Vol 6, No 5, May 2011, ISSN 1819- 6608.

[2] B B Patil, P D Kumbhar, Strength and Durability Properties of High Performance Concrete Incorporating High Reactivity Metakaolin: International Journal of Modern Engineering Research (IJMER), Vol 2, Issue 3, May- June 2012 pp- 1099-1104, ISSN: 2249-6645.

[3] Dr. S Sundararaman, S Azhagarsamy; Performance of Ultra High Performance Concrete Containing Mineral Admixtures: SSRG International journal of Civil Engineering Vol: 2, Issue 10, October 2015.

[4] Jianxin Ma, Marko Orgass, Comparative Investigations on Ultra-High Performance Concrete with and without Coarse Aggregates: Kassel, Germany September 2004.

[5] Nagesh N Meleka, Alaa A Bashandy, Mohamed A Arab, Ultra High Strength Concrete Using Economical Materials: International Journal Of Current Engineering And Technology (IJCET) , ISSN 2277-4106,Volume 3, No 2, June 2013.

[6] Prabhat Rajan Prem, B H Bharatkumar, Nagesh R Iyer, Mechanical Properties of Ultra High Performance Concrete: International journal of Civil, Environmental, Structural, Construction and Architectural Engineering Vol: 6, No 8, 2012.

[7] R. Yu , P. Tang, P. Spiesz, H.J.H. Brouwers, A study of multiple effects of nano-silica and hybrid fibres on the properties of Ultra-High Performance Fibre Reinforced Concrete (UHPFRC) incorporating waste bottom ash (WBA), Construction and Building Materials 60 (2014) 98–110, 17 February 2014.