EXPERIMENTAL INVESTIGATION ON STRENGTH PERFORMANCE OF ULTRA HIGH PERFORMANCE CONCRETE

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ABSTRACT

Ultra High Performance concrete (UHPC) is one of the very latest trends in concrete technology and design of concrete structures. The typical composition of UHPC is based on fine aggregate mortar with a compressive strength over 150 MPa .Another typical property is the content of relatively fine fibers .The quantity of the fibers in concrete should assure higher load bearing capacity of a cracked cross section in comparison with an uncracked one. The high percentage of silica fume in UHPC (almost 25% of cement weight) changes the hydration kinetics and mechanical properties. Silica fume acts as micro filler in UHPC. It also reacts with calcium hydroxide, thus increasing final strength. Ultra High Performance concrete opens door to more slender structural elements and aesthetic designs than is possible with ordinary and other high strength concrete. The use of UHPC leads to smaller cross sections and hence it reduces the dead load of the structure. UHPC is preferred not only for economic al design but also for the durability which is one of the concerns of material engineering. It's extremely dense micro structure makes UHPC quite suitable for architectural applications also. In this work silica fume was replaced with cement for 20% and steel fibre was added from 1% to 4%.compression strength and split tensile strength was performed and results were found to be good

1.INTRODUCTION

An Ultra High Performance Concrete is a high strength, ductile material formulated by combining Portland cement, silica fume, quartz flour , fine silica sand, high range water reducer, water and steel or organic fibers. UHPC is relatively new type of ultra high strength concrete first introduced in 1944. It offers many advantages over normal strength concrete and obtained by adding short and metallic fibers. Cracks can be prevented by fiber reinforcement. During multi cracking of material, action known as "bridging" of cracks by fibers involves many micro mechanisms, which are more or less solicited according to the angle reigning between the direction of the local reinforcement (Fiber) and the normal to the place of cracking.

The main objective of the work is
To find the compressive ,split tensile strength for silica fume and steel fibre replaced concrete .
Some examples of such standards currently used in relation to HPC are:

- Ease of placement
- Compaction without segregation
- Early age strength
- Long-term mechanical properties
- Permeability
- Density
- Heat of hydration Toughness
- Volume stability
- Long life in severe environments
- Depending on its implementation, environmental

3.EXPERIMENTAL INVESTIGATION

CEMENT

Ordinary Portland cement of 53 grades (ultratech) was used for the study. Laboratory tests were conducted on cement to determine standard consistency, initial setting time, final setting time. Specific gravity of cement 3.15.Initial and final setting time 30min and 600min

FINE AGGREGATE AND COARSE AGGREGATE

Locally available good river sand was used. Laboratory tests were conducted on fine aggregate to determine the different physical properties as per IS 383(part III)-1970. River sand passing through 2.36 mm was used in this work. Specific gravity of sand 2.72

Size of coarse aggregate used in this work was 12.5mm .specific gravity of coarse aggregate is 2.86

WATER

Portable Water is generally considered as being acceptable. Clean water is used for mixing and curing of concrete.

SILICA FUME

Silica fume, also known as **microsilica**, is an amorphous (non-crystalline) polymorph of silicon dioxide, silica. It consists of spherical particles with an average particle diameter of 150 nm. Silica fume purchased from market was used. Specific gravity of silica fume was 2.5.

CHEMICAL ADMIXTURES

Super plasticizers also known as HRWR from FOSROC Company was used in this work. This super plasticizer helps to reduce water cement ratio

Steel Fibers

Steel fibers with 0.5mm diaand aspect ratio of 30 was used in this work

Mix proportions

The UHPC mix of trial mix 1:0.5:1.82ratio was used. The water cement ratio was reduced from 0.4 to 0.30 by adding chemical admixtures. Cement was replaced by 20% silica fume. The fibers are also added with different percentages(0 to 4%). The mix proportions are shown in Table 1

Table 1 – Mix proportions

DESIGNATION	Percentage replacement of SILICA FUME WITH CEMENT	Percentage Addition of STEEL FIBER (%)
M1	0	0
M2	20	1
M3	20	2
M4	20	3
M5	20	4

RESULTS AND DISCUSSION

COMPRESSIONSTRENGTH TEST

The cube specimen is of the size 150 x 150x150 mm were cast as per IS 516:1959. Curing was done for 1day,3days,7days,14days,28days and 56 days respectively Average compressive strength is shown in table 2.

Table 2 compressive strength of UHPC for different curing period

Curing period	**M_1**	**M_2**	**M_3**	**M_4**	**M_5**
	Average Compressive strength (N/mm^2)				
1 day	13.19	15.47	18.92	24.30	23.17
3 days	31.42	39.21	40.97	43.28	42.01
7 days	41.32	42.94	44.35	47.28	45.86
14 days	49.72	52.67	56.09	62.57	57.49
28 days	53.19	57.28	59.27	69.79	62.94
56 days	69.42	71.45	74.79	82.51	79.57

SPLIT TENSILE STRENGTH TEST

Split tensile test was carried as per IS 516:1959. Concrete cylinder of size 150mm diameter and 300mm height were casted. Proper quality control was maintained during casting.curing was done for 1day,3days,7days,14days,28days and 56 days respectively and calculation of strength was done using the formula $2P/\pi dl$.

Average Split tensile strength is shown in table 3

Table 3 Split tensile strength of UHPC for different curing period

Curing period	**M_1**	**M_2**	**M_3**	**M_4**	**M_5**
	Average Split tensile strength (N/mm^2)				
1 day	0.5	0.69	0.89	1.10	1.05
3 days	1.76	1.78	1.88	2.66	2.54
7 days	2.3	2.69	2.93	3.68	3.47

14 days	3.45	3.63	3.77	4.57	4.41
28 days	4.66	4.88	4.92	5.42	5.31
56 days	5.96	6.12	6.56	7.21	6.98

CONCLUSION

Based on the experimental investigation, the following conclusions are drawn within the limitation.

1. The ultra-high performance concrete with trial mix ratio was found to give more strength but it was equal to high performance concrete.
2. But with the minimum ingredients More than 80MPa was achieved
3. Addition of mineral admixtures gives more strength up to certain percentage of replacement.
4. Compression strength both for normal and acid curing, split tensile strength, flexural strength test for 20% replacement of silica fume and fiber addition from 1% to 4% were found to be better than control concrete. Using of mineral admixtures are eco friendly. Setting time of these silica fume was little more than normal concrete. Ultra high performance concrete can be achieved only by proper maintaining of quality control.
5. Addition of steel fibers in the UHPC increased the 28 and 56 days cube compressive strength.
6. There was an increase in the cylinder tensile strength with the addition of steel fibers.
7. With the addition of steel fibers up to 3% strength was good.

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