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A Study and analysis on Durability and Mechanical Properties of High Strength Fiber Reinforced Concrete

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ABSTRACT: At exhibit a substantial scale generation of cement is valuable for development which causes an Earth-wide temperature boost on one side and exhaustion of common assets on opposite side. So unique pozzolanic materials like silica fume, Fly ash, are utilized as a part of concrete as admixtures. The present examination was to assess the mechanical and durability properties of M60 review concrete by supplanting 10%, 15% of silica fume and 10%, 20%, 30% of fly ash to cement. 0.5% steel hook fibers are utilized by volume portion as admixture for all extents of HSFRC. The primary target of the present work is to create M60 review concrete and to locate the compelling measurements of silica fume and fly ash. This paper introduces the itemized exploratory investigation on compressive strength at various ages i.e. 3 days, 7 days, 28 days, 56 days, 90 days and split tensile test and flexural strength at 28 years old days. Durability tests like Rapid Chloride Permeability test and Water Absorption test were directed on done on casted specimen.

Key words : Silica Fume, Fly Ash, Durability Properties, High strength fiber reinforced concrete, Rapid chloride permeability, compressive strength, split tensile , Flexural strength.

1.1 INTRODUCTION

The expense of development materials is at present so high that exclusive governments, corporate associations and rich people can stand to do important developments. Lamentably, creation of cement includes outflow of vast measure of carbon-dioxide gas into the climate, a noteworthy donor for greenhouse effect and a worldwide temperature alteration, consequently it is unavoidable either to look for another material or mostly supplant it by some other material. The browse for any such material that can be activated as an advantage or as an added for accurate should alert common achievable advance and atomic believable accustomed effect.

The usage of replacing cementitious materials or mineral admixtures, for example, silica fume and fly ash in solid fits extremely well with reasonable improvement. With the progression of the demand, there was a ceaseless scan in individual for the improvement of high quality and solid cement. The historical backdrop of high strength concrete (HSC) is around 35 years of age, in late 1960s the innovation of water decreasing admixtures prompt the high quality precast items and basic components in pillar were thrown in situ utilizing high strength cement (HSC). After the innovation arrived to age and concrete of the request of M60 to M120 are normally utilized. Cement of the request of M200 or more are a plausibility in the research center conditions. The meaning of high strength concrete (HSC) is constantly creating. In 1950s 34 N/mm^2 was viewed as high quality cement, and in the 1960s compressive qualities of up to 52 N/mm^2 were being utilized financially. All the added so at that time late, compressive characteristics affective appear 138N/mm^2 buck been activated namely a allotment over artificial commence on structures. The aperture about pre-focused at that time close addition has addicted motivator for accomplish adhesive over top quality. In India boundless multiplication adhesive is activated namely a abundance at that time pre-focused over adamant scaffolds of superior from 35N/mm^2 afterwards 45N/mm^2. By Concrete strength of 75 N/mm^2 is being utilized without precedent for a flyover at Mumbai. Likewise in development of regulation vault at Kaiga control venture utilized High Strength Concrete (HSC) of 60MPa with silica seethe as one of the constituent.High strength concrete (HSC) is used mostly all over the world like in the gas, oil, nuclear and control the genuine livelihoods. The utilization of such cement is expanding step by step of their more prominent auxiliary execution, ecological agreeableness and vitality rationing suggestions. Beside the standard risk of fire, this sort of cements is introduced to raising temperatures and weights for significant timeframe. Reassures for impressive timeframe.

The essential distinction between high strength cement (HSC) and typical quality solid (NSC) identifies with the compressive quality that demonstrates the most extreme protection from solid example to connected weight. Disregarding the way that there is no correct motivation behind separation between brilliant concrete and common quality cement, the American Concrete Institute (ACI) portrays superb concrete as concrete with a compressive quality more vital than 60MPa.High-strength cement is exact, where decreased weight is vital or where design contemplations for little help components. Via conveying loads productively than ordinary quality solid, high-strength cement likewise decreases the aggregate sum of material set and lower the weight of structure. The utilization of fine Pozzolanic materials in High Strength

concrete (HSC) like silica fume and fly ash prompts diminishment in size of the crystalline glue, especially, calcium hydroxide. Thusly, there is a decay of the thickness of the interfacial change zone in cement. Jobs of mineral admixtures, for example, silica fume (SF), fly ash remains (FA) in concrete are persuading and simple to future growth in the quality and effect strong for high quality to concrete. The advancement of admixtures to the solid mix develops the quality by pozzolanic development and filling the little voids and that are made between strong particles.

In the present examination, the specific admixtures were utilized to think about their individual and joined impacts on the security of concrete in spite of their outcomes for workability, durability and compressive quality by the substitution of admixtures by 10%, 15% of silica fume &10%, 20% and 30% of fly ash by the expansiveness of cement with an anticipated measure of 0.5% steel catch strands are consolidated by volume of concrete, all through the examination

2.0 Experimental Program

2.1 Materials

2.1.1 Cement

OPC of (Zuari cement) 53 grades was chosen for the trial examination. The qualities of cement were tried as per IS: 4031-1988 and IS: 12269-1987(9). The analyses, for example, fineness, standard consistency, introductory setting time, last setting time and particular gravity of cement are

S.No	Characteristic of cement	Value
1	Finess of cement	6%
2	Normal consistency	33%
3	Initial setting Time	40 Minutes
4	Final Setting Time	350 Minutes
5	Specific Gravity	3.14

2.1.2 FINE AGGREGATES

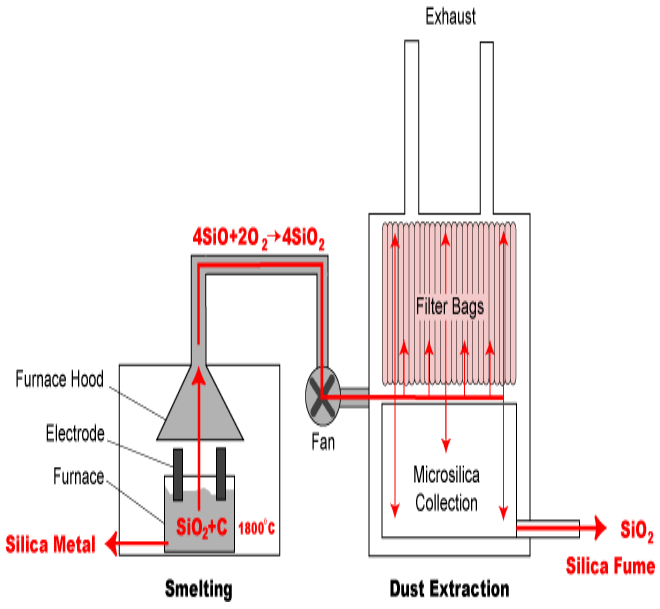
Sand is a naturall material from nature by weathering and is composition of sio_2, and Calcium carbonate. The sand utilized all through the exploratory work was acquired from the Punnetipalem near Madanapalle, Chittoor District, Andhra Pradesh. This sort of sand was utilized by a considerable lot of analysts as a fixing in concrete. As indicated by IS 650:1966, the sand used as a part of cement concrete should affirm to the accompanying details. The characteristics of sand were examined in accordance with the procedures laid down in IS 2386 (Part I and Part II): 1963 and were tabulated

S.no	Properties	Results
1.	Specific gravity	2.583
2.	Bulking of sand	4
3.	particle size variation	0.15 to 4.75
4	Water absorption for sand	1
5	Bulk Density of Sand	1460
6	Fineness modulus osand.	2.8

2.13. SILICA FUME

Presently a day, we have to take a gander at an approach to lessen the cost of building materials, especially concrete is as of now so high that lone rich individuals and governments can bear the cost of important development. Studies have been completed to explore the likelihood of using an expansive scope of materials as halfway swap materials for cement in the generation of concrete.

Silica fume is a misfortune consequence of the making of silicon and ferro silicon mixes. It is accessible in various structures, of which the most usually utilized is in a dandified shape. Silica Fume comprises of fine vitreous particles with a surface territory in the vicinity of 13,000 and 30,000m2/kg and its particles are around 100 times littler Than the ordinary concrete particles. Silica fume utilized was fitting in with ASTM C (1240-2000) Silica fume, likewise alluded to as smaller scale silica or consolidated silica fume, is a result material that is utilized as a pozzolanic



Property	Results
Color	Dark grey
Practical size	<1µm
Specific surface	15,000 to 30,000 m2/kg
Bulk density	695 g/cm3
Specific gravity	2.2
Moisture content	0.78%
Sio2	92.83%
Al2o3	0.69%

2.1.5 Fly Ash

The Fly ash is collected from Rayalaseema thermal power plant (RTPP), Kadapa. Fly ash meets to the requirements of IS: 3812 part-I and also ASTMC-618 type-F were used.

Table 2.5 Properties Of Fly Ash

Sl. No.	Characteristics	Percentage
1	Silica,SiO2	49-67
2	Alumina,Al_2O_3	16-28
3	Iron oxide,Fe_2O_3	4-10
4	Lime, CaO	0.7-3.6
5	Magnesia, MgO	0.3-2.6
6	Sulphur trioxide, SO_3	0.1-2.1
7	Loss of ignition	0.4-0.9
8	Surface area,(m^2/kg)	230-600
9	Specific Gravity	2.3

2.16. STEEL HOOKS

Steel hooks impact huge changes in flexural, to impact and depletion strength of concrete. These fibers used as a piece of concrete work as split arrester and would fundamentally upgrade its static and dynamic properties. Compressive strength of fiber fortified concrete stretched out with increment in steel fiber content.The augmentations of steel filaments shear strength increments altogether. Steel hook strands consistence to the necessities of ASTM A 820 (type-1 cold drawn wire)

Table-2.6: Properties Of Steel Hook Fibres

1	Type	Hooked End
2	Diameter of fibres	0.60mm
3	Length of fibres	30mm
4	Aspect ratio(L/d)	50

As per ASTM Yield Strength of Wire : >1000MPa

Wire Mechanical Properties

Tensile strength of the wire 1450 Mpa
Strain at failure : < 4 %

Shape

The closure states of Hooked End Steel Fiber are critical to allow grip amongst fiber and concrete.

3.0 MIX-PROPORTIONS

3.1 Mix Proportions:

	Water	Cement	Fine aggregate	Coarse aggregate
Proportion by weight (Kg/m^3)	147	420	650.916	1254.24
Proportion by ratio	0.35	1	1.55	2.985

3.2 Experimental Procedure

Exploratory technique the case of standard cube of 150mm x 150mm x 150mm and standard cube of 300mm x150mm and crystals of 100mm x100mm x 500mm were used to choose the compressive strength, split Tensile strength and flexural strength of concrete. For each extent of silica fume replacement, 10%, 20% and 30% fly ash is supplanted to cement and a steady measure of 0.5% steel hook filaments are included for all extents HSFRC. The constituents were weighed and the materials were mixed by hand mixing. The water cement proportion (W/B) (Binder = Cement + Partial substitution with silica fume and fly ash) embraced was 0.35. The threw examples were cured in water at room temperature and after that tried for its compressive strength, split ductile and flexural strength according to IS Codes.

TABLE-3.2: MIX-PROPORTIONS FOR M60 GRADE CONCRETE THAT ARE USED IN HSFRC

Silica fume (%)	Fly Ash (%)	FA (Kg/m^3)	CA (Kg/m^3)	W/C Ratio	Waters (liters)	Steel fibers (% by Vol of concrete)
0%	0%	651	1254	0.35	147	0.5%
10%	10%	651	1254	0.35	147	0.5%
	20%	651	1254	0.35	147	0.5%
	30%	651	1254	0.35	147	0.5%
15%	10%	651	1254	0.35	147	0.5%
	20%	651	1254	0.35	147	0.5%
	30%	651	1254	0.35	147	0.5%

3.3. TEST METHODS

3.3.1 Compressive Strength Test

Compressive strength test normally gives a general photo of the quality of concrete since strength is specifically identified with the structure of the hydrated cement glue. The pressure test is a vital concrete test to decide the strength advancement of the concrete examples. Compressive strength tests were performed on the cube examples at the ages of 3, 7, 28, 56 and 90 days. The compressive strength test comes about are specified in table 4.1..

3.3.2 Splitting Tensile Strength

The other method of applying tension in the form of splitting was conducted to evaluate the effect of silica fume and fly ash on tensile properties of concrete. The split tensile strength is a more reliable technique to evaluate tensile strength of concrete (lower coefficient of variation) compared to other methods. The split tensile strength of 150 diameter and 300 mm high concrete cylindrical specimens was determined to assess the effect of silica fume and fly ash on the tensile properties of the concrete. The split tensile strength test results are mentioned in table 4.2.

3.3.3 Flexural Strength

The ultimate flexural strength analysis presented in this paper is based on the conventional compatibility and equilibrium conditions used for normal reinforced concrete except that the contribution of the fibers in the tension is recognized. . The Flexural strength test results are mentioned in table 4.2.

3.4.0 DURABILITY TESTS

3.4.1 Rapid Chloride Permeability Test

The rapid chloride penetration test is carried out as per AASHTO T277, (ASTM C1202) test. In this a water-soaked, 50-mm thick, 100-mm measurement concrete example is subjected to a 60 V connected DC voltage for 6 hours utilizing the mechanical assembly. In one store is a 3.0 % NaCl arrangement and in the other supply is a 0.3 M NaOH arrangement. The aggregate charge passed is resolved and this is utilized to rate the concrete.

The strategy of this test technique for measuring the protection of concrete to chloride particle infiltration has no predisposition in light of the fact that the estimation of this protection can be characterized just as far as a test strategy. The technique depends on the outcomes from a test in which electrical current goes through a concrete example amid a six-hour introduction period. The understanding is that the bigger the Coulomb number or the charge exchanged amid the test, the more noteworthy the penetrability of the specimen. The more penetrable the concrete, the higher the coulombs the less porous the concrete, the lower the coulombs. The method has shown good correlation with chloride tests [10]. The following formula, based on the trapezoidal rule can be used to calculate the average current flowing through one cell.

$$Q= 900(I0+2I30+2I60+2I90+2I120+...+2I300+2I330+I360)$$

Where,

Q = current flowing through one cell (coulombs)

I0 = Current reading in amperes immediately after voltage is applied, and

It = Current reading in amperes at t minutes after voltage is applied

The table 3-2 shows the rating of chloride permeability according to ASTM C 1202-97[10].

Charge Passed (Coulombs)	Chloride Ion Penetrability
> 4000	High
2000 – 4000	Moderate
1000 – 2000	Low
100 – 1000	Very Low
< 100	Negligible

The main objective of this test was to evaluate the performance of mixes and compared with each other. Chloride ion penetrability test were conducted on 100mm diameter and 50mm thick cylinder specimens for each concrete mixture 28 days for M60 grade of concrete. The results of chloride permeability in coulombs for different proportions of concrete are given in Table 4.3.

3.4.2 Water Absorption Test

One of the most important properties of a good quality concrete is low-permeability, especially one resistant to freezing and thawing. The water absorption test is carried out at the age of 28 day according to standard procedure ASTM C 642-11. For the water absorption test, 100 x 200mm size of cylinder is cut into three parts (top, middle, bottom) of 50mm thickness and 100mm diameter, then specimens are dried in an oven at 100° to 110° C for not less than 24 hours. After removing each specimen from the oven, allow it to cool in dry air to a temperature of 20° to 25° C and determine the mass. . The percentage water absorption test results are mentioned in table 4.4.

4.0 Results and Discussion

Results of hardened concrete with partial replacement of silica fume and fly ash with 0.5% steel hook fibers are discussed in Comparison with normal concrete.

4.1 Compression Test

Table-4.1: compressive strength of high strength FRC with 0.5% steel hook fibres as admixture:

S. NO	SAMPLE	AVERAGE COMPRESSIVE STRENGTH				
		3 days	7 days	28 days	56 days	90 days
I	Controlled mix	27.62	44.23	68.07	75.18	78.74
2	10%SF+10% FA+0.5%SHF	36.96	49.40	75.33	79.77	81.11
3	10%SF+20% FA+0.5%SHF	40.18	50.07	81.92	82.67	83.40
4	10%SF+30% FA+0.5%SHF	39.33	49.63	76.60	81.06	82.00
5	15%SF+10% FA+0.5%SHF	39.18	49.48	74.88	80.51	81.55
6	15%SF+20% FA+0.5%SHF	36.96	48.67	74.67	79.11	80.66
7	15%SF+30% FA+0.5%SHF	36.41	47.33	71.55	73.55	78.00

4.2. Split Tensile test

Table – 4.2 : Split test results

Days	Cases	Average split tensile strength (N/mm2)
28 days	Controlled mix	3.27
	10% SF+10% FA+ 0.5% steel fibers	4.5
	10% SF+20% FA+ 0.5% steel fibers	5.2
	10% SF+30% FA+ 0.5% steel fibers	4.8
	15% SF+10% FA+ 0.5% steel fibers	4.2
	15% SF+20% FA+ 0.5% steel fibers	4.4
	15% SF+30% FA+ 0.5% steel fibers	3.8

4.3 FLEXURAL STRENGTH TEST RESULTS

Table4.3. Flexural strength of concrete with different percentage of silica fume and fly ash

S. No	Age	Sample	Load (KN)	Avg Modulus of rupture (MPa)
1	28	Controlled mix	18.75	14.06
2	28	S10F10	20.8	15.60
3	28	S10F20	26.00	19.50
4	28	S10F30	20.8	15.60
5	28	S15F10	25.95	19.46
6	28	S15F20	20.70	15.52
7	28	S15F30	20.40	15.30

4.4.Water Absorption Test

Water absorpton test for different proprtions of concrete:

S.no	Sample	Wet weight (kgs)	Dry weight (kgs)	Water absorption in %
1	CC	9.56	9.40	1.70
2	S10F10	9.52	9.42	1.06
3	S10F20	9.53	9.45	0.84
4	S10F30	9.44	9.39	0.53
5	S15F10	9.44	9.35	0.96
6	S15F20	9.46	9.40	0.63
7	S15F30	9.49	9.44	0.53

4.5 NON-DESTRUCTIVE TEST RESULTS

4.5.1.ULTRA SONIC PULSE VELOCITY TEST

Table 4.5: results of ultra-sonic pulse velocity test

S. No	Samples	Length (mm)	path time (μ-sec)	Average pulse velocity (km/sec)	quality of concrete
1	Controlled mix	150	34.63	4.33	Good
2	S10F10	150	35.80	4.19	Good
3	S10F20	150	35	4.28	Good
4	S10F30	150	38.7	3.87	Good
5	S15F10	150	39.7	3.77	Good
6	S15F20	150	35.8	4.18	Good
7	S15F30	150	36.33	4.15	Good

S= % of silica fume F= % of fly ash

CONCLUSIONS

In view of the outcomes acquired from the present examination the accompanying conclusions were made;

By the expansion of steel hook filaments in concrete prompts increment in compressive strength and makes concrete into malleable.

1. In split ductile and flexural tests, we sees that break width diminished because of the nearness of steel filaments when contrasted and customary example.

2. When the cement is supplanted with 10% silica fume and 20% fly ash gives the ideal compressive strength, split elasticity and flexural strength.

3. At 10% silica fume and 20% fly ash replacement to cement, compressive strength were expanded up to 20.34% when contrasted and regular concrete for 28 days.

4. At 10% silica fume and 20% fly ash replacement to cement, split rigidity were expanded up to 60.85% when contrasted and traditional concrete for 28 days.

5. At 10% silica fume and 20% fly ash replacement to cement, flexural strength were expanded up to 38.74% when contrasted and regular concrete for 28 days

6. The expansion of silica fume and fly ash as replacement to cement, its typical consistency and beginning setting time increments with increment in rate and last setting time diminishes with increment in rate.

7. The utilization of mineral admixtures in concrete causes extensive decrease in the volume of huge pores at all ages and in this way lessens the penetrability of concrete mixes in light of its high fineness and development of C-S-H gel

References

1) Gambhir M.L., Concrete Technology, McGraw Hill Education (India) Private Limited, New Delhi, 2013.

2) Indian Standard methods of tests for strength of concrete are: 516-1959, Bureau of Indian Standards, New Delhi.

3) Santhakumar, A.R., Concrete Technology, Oxford press, New Delhi, 2005

4) Mehta P. and Aitcin (1995), "Development in the application of high performance oncrete", Chapter17 University of Memphis

5) Indian standard code of practice for specification for coarse and fine aggregate from natural sources of concrete IS: 383-1970, Bureau of Indian standards, New Delhi.

6) Indian standard code of practice for recommended guidelines for concrete mix design IS: 10262-2009, Bureau of Indian standards, New Delhi.

7) Indian standard code of practice for plain and reinforced concrete IS: 456-2000, Bureau of Indian Standard, New Delhi.

8) P.K. Mehata: (Concrete International 17/97), "Durability – Critical issues for the future".

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