A Study On Mechanical And Durability Properties Of High Strength Fiber Reinforced Concrete With Replacement Of Cement By Silica Fume And Fly Ash

A GOWRI PRASAD RAO [1] B.FAYAZ[2]

[1]M. Tech Student, Department of civil engineering P.V.K.K Institute of Technology, Sanapa, Road, Rudrampeta Rd, Anantapur, Andhra Pradesh 515001

[2]Assistant professor, Department of civil engineering P.V.K.K Institute of Technology, Sanapa, Road, Rudrampeta Rd, Anantapur, Andhra Pradesh 515001

Abstract *High-performance concrete is defined as concrete that meets special combinations of performance and uniformity requirements that cannot always be achieved routinely using conventional constituents and normal mixing, placing, and curing practices. Ever since the term high-performance concrete was introduced into the industry, it had widely used in large-scale concrete construction that demands high strength, high flowability, and high durability. A high-strength concrete is always a high-performance concrete, but a high-performance concrete is not always a high-strength concrete. Durable concrete Specifying a high-strength concrete does not ensure that a durable concrete will be achieved. It is very difficult to get a product which simultaneously fulfill all of the properties. So the different pozzolanic materials like silica fume, Fly ash, are some of the pozzolanic materials which can be used in concrete as partial replacement of cement, which are very essential ingredients to produce high performance concrete. So we have performed XRD tests of these above mentioned materials to know the variation of different constituent within it. Also it is very important to maintain the water cement ratio within the minimal range, for that we have to use the water reducing admixture i.e superplasticizer, which plays an important role for the production of high performance concrete. So we herein the project have tested on different materials like silica fume to obtain the desired needs. Also X-ray diffraction test was conducted on different pozzolanic material used to analyse their content ingredients. We used fiber in different percentage i.e 0.0%, 0.1%, 0.2%, 0.3% to that of total weight of concrete and casting was done. Finally we used different percentage of silica fume with the replacement of cement keeping constant fiber content and concrete was casted. In our study it was used two types of cement, Portland slag cement and ordinary Portland cement. We prepared mortar, cubes, cylinder, prism and finally compressive test, splitting test, flexural test are conducted.*

I.INTRODUCTION

1.1 GENERAL

The cost of construction materials is currently so high that only governments, corporate organizations and wealthy individuals can afford to do meaningful constructions. Unfortunately, production of cement involves emission of large amount of carbon-dioxide gas into the atmosphere, a major contributor for green house effect and global warming, hence it is inevitable either to search for another material or partly replace it by some other material. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact. The use of supplementary cementitious materials or mineral admixtures such as silica fume as fly ash in concrete fits very well with sustainable development. The volume of silica fume and fly ash in concrete mixtures contain lower quantities of cement.

With the passage of time to meet the demand, there was a continual search in human being for the development of high strength and durable concrete. The history of high strength concrete (HSC) is about 35 years old, in late 1960s the invention of water reducing admixtures lead to the high strength precast products and structural elements in beam were cast in situ using high strength concrete (HSC). After the technology has come to age and concrete of the order of M60 to M120 are commonly used. Concrete of the order of M200 and above are a possibility in the laboratory conditions. The definition of high strength concretes (HSC) is continually developing. In the 1950s 34 N/mm^2 was considered high strength concrete, and in the 1960s compressive strengths of up to 52 N/mm^2 were being used commercially. More recently, compressive strengths approaching 138N/mm^2 have been used in cast-in-place buildings. The dawn of pre-stressed concrete technology has given incentive for making concrete of high strength. In India high strength concrete is used in pre-stressed concrete bridges of strength from 35N/mm^2 to 45N/mm^2. Presently Concrete strength of 75 N/mm^2 is being used for the first time in one of the flyover at Mumbai. Also in construction of containment dome at Kaiga power project used High Strength Concrete (HSC) of 60MPa with silica fume as one of the constituent.

High strength concrete (HSC) is used extensively throughout the world like in the gas, oil, nuclear and power industries are among the major uses. The application of such concrete is increasing day by day due to their greater structural performance, environmental friendliness and energy conserving implications. Apart from the usual risk of fire, these concretes are exposed to high temperatures and pressures for considerable period of time.

The primary difference between high-strength concrete (HSC) and normal-strength concrete (NSC) relates to the compressive strength that shows the maximum resistance to concrete sample to applied pressure. Although there is no precise point of separation between high-strength concrete and normal-strength concrete, the American Concrete Institute (ACI) defines high-strength concrete as concrete with a compressive strength greater than 60MPa.

High-strength concrete is precise, where reduced weight is important or where architectural considerations for small support elements. By carrying loads very efficiently than normal-strength concrete, high-strength concrete also reduces the total amount of material placed and lower the overall expenditure and weight of the structure. High-strength concrete columns can hold more weight and therefore be made slimmer than regular strength concrete structures, which allows for more useable space, especially in the lower floors of buildings. High Strength Concrete is also used in other engineering structures like bridges, fly-over etc. From the general principles behind the design of high-strength concrete mixtures, it is clear that high strengths are made possible by reducing porosity, in homogeneity, and micro cracks in the hydrated cement paste and the transition zone.

The utilization of fine Pozzolanic materials in high-strength concrete (HSC) like silica fume and fly ash leads to reduction in size of the crystalline compounds, particularly, calcium hydroxide. Consequently, there is a reduction of the thickness of the interfacial transition zone in high-strength concrete. Applications of mineral admixtures such as silica fume (SF), fly ash (FA) in concrete are effective and easy to future increase in the strength and make durable for high strength concrete. The addition of admixtures to the concrete mixture increases the strength by pozzolanic action and filling the small voids and that are created between cement particles.

In the present study, the different admixtures were used to study their individual and combined effects on the resistance of concrete in addition to their effects on workability, durability and compressive strength by the replacement of admixtures by 10%, 15% of silica fume &10%, 20% and 30% of fly ash by the weight of cement with a constant amount of 0.5% steel hook fibers are added by volume of concrete, throughout the study.

1.2 HIGH STRENGTH CONCRETE (HSC)

High-strength concrete structures can hold more weight and therefore be made slimmer than normal strength concrete columns, which allows for more useable space, especially in the lower floors of buildings. High-strength concrete is specified where reduced weight is important or where architectural considerations call for small support elements. By carrying loads more efficiently than normal-strength concrete, high-strength concrete also reduces the total amount of material placed and lower the overall cost of the structure.

1.3. HIGH PERFORMANCE CONCRETE (HPC):

In recent years, the terminology "High-Performance Concrete" has been introduced into the construction industry. The American Concrete Institute (ACI) defines high-performance concrete as concrete meeting special combinations of performance and uniformity requirements that cannot be always achieved routinely by using conventional constituents and normal mixing, placing and curing practices. A commentary to the definition states that a high-performance concrete is one in which certain characteristics are developed for a particular application and environment.

Most high-performance concretes have a high cementitious content and a water-cementitious material ratio of 0.4 or less. However, the proportions of the individual constituents changes depending on local preferences and local materials. Mix proportions developed in one part of the country do not necessarily work in different locations. Many trial batches are usually prepared before a successful mix is developed. High-performance concretes are also more sensitive to changes in constituent material properties than conventional concretes. Variations in the chemical and physical properties of the cementitious materials and chemical admixtures need to be carefully monitored. Substitutions of alternate materials can result in changes in the performance characteristics, which may not be acceptable for high-performance concrete. This means that a greater degree of quality control is required for the successful production of high-performance concrete.

1.4. HIGH STRENGTH FIBER REINFORCED CONCRETE (HSFRC)

The use of high strength concrete (HSC) is continuously increasing due to its mechanical and durability advantages over normal strength concrete (NSC). In high-rise buildings, HSC can reduce the dimensions of the lower-story columns, which makes it a more cost-effective choice for builders than NSC, HSC is more brittle in comparison with NSC and that the confinement provided to HSC is less effective than in NSC. Therefore, greater confinement is required for the structures made from higher strength concrete to achieve similar strength and ductility enhancements.

The addition of short discrete fibers (steel hook fibers) into the High Strength Concrete mixture can increase compressive strength and ductility, as already confirmed by several studies. These studies have also shown that the combination of discrete fibers can reduce the relatively large amount of confinement reinforcement required by design codes e.g., ACI 318-11 and CSA 23.3-04 Canadian Standard Association for HSC columns. Another advantage of adding discrete fibers to HSC mixtures in reinforced concrete structures is to prevent the premature separation of the concrete cover. Concern in using high strength fiber-reinforced concrete (HSFRC) for structural members has increased in recent decades both for scientists and producers, and especially in the field of precast members. Several experimental and theoretical investigations highlight the effectiveness of using HSFRC for members of framed structures.

II.REVIEW OF LITERATURE

2.1. INTRODUCTION:

As our aim is to develop high strength concrete which does concern on the strength of concrete, it also having many other aspects to be fulfilled like less porosity, capillary absorption, durability. Also now a day's one of the great applications in various structural fields are high strength fiber reinforced concrete, which is getting popularity because of its positive effect on various properties of concrete.

2.2. TYPE OF ADMIXTURES

According to ASTM C-125, admixture is a material other than water, aggregates and hydraulic cement used as an ingredient of concrete and added to the batch immediately before or during mixing. If these materials are blended during the manufacture of cement, it is called as an additive.

2.3 SILICA FUME

Now a day, we need to look at a way to reduce the cost of building materials, particularly cement is currently so high that only rich people and governments can afford meaningful construction. Studies have been carried out to investigate the possibility of utilizing a broad range of materials as partial replacement materials for cement in the production of concrete.

Silica fume is a waste by-product of the production of silicon and Ferro-silicon alloys. It is available in different forms, of which the most commonly used is in a dandified form. Silica Fume consists of very fine vitreous particles with a surface area between 13,000 and 30,000m2/kg and its particles are approximately 100 times smaller than the average cement particles. Silica fume used was conforming to ASTM C (1240-2000) Silica fume, also referred to as micro silica or condensed silica fume, is a byproduct material that is used as a pozzolanic.

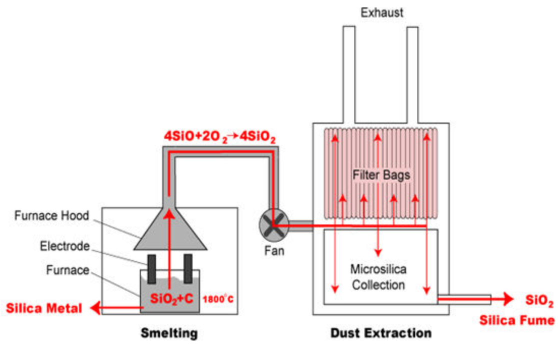


Fig.2.1. Silica Fume capturing process in Silicon Industry.

This byproduct is a result of the reduction of high-purity quartz with coal in an electric arc furnace in the manufacture of silicon or ferrosilicon alloy. Silica fume rises as an oxidized vapor from the 2000°C furnaces. When it cools it condenses and is collected in huge cloth bags. The condensed silica fume is then processed to remove impurities and to control particle size. (S. Bhanja, 2004 et. al)

Fig2.2: Sample of silica fume used in concrete

TABLE2.1: PHYSICAL AND CHEMICAL PROPERTIES OF SILICA FUME

Mandatory Chemical & Physical requirements	Specifications		
	ASTM C1240	Typical Result	Frequency
SiO_2 (%)	>85.0	92.83%	400 MT
Alkalies (as equivalent NaO2%)	Report	Report	400 MT
Moisture (%)	<3.0	0.8%	400 MT
Loss on ignition (%)	<6.0	2.4%	400 MT
Specific surface (BET-m^2/gram)	>16	>18	3200mt/4months
Bulk density (kg/m^3)	550-700	600-650	400 MT
Pozzo Activity index % - 7 days accelerated curing	>105	>115	3200mt/4months
Retained on 45 micron sieve %	<10	<2	400 MT
Variation from avg. Retained on 45 micron (% points)	<5	<5	Avg. of last 10 tests
Density (kg/m^3)	Report	Report	400MT

2.4 STEEL HOOK FIBRES

Steel fibres make considerable improvements in flexural, impact and fatigue strength of concrete. These fibres used in concrete work as crack arrester and would substantially improve its static and dynamic properties. Compressive strength of fibre reinforced concrete increased with increase in steel fibre content. The addition of steel fibres shears strength increases significantly.

Fig 2.3: Sample of steel hook fibers that are used in concrete.

West Nippon Expressway Company Limited examined on development of high-strength fiber reinforced concrete for highly durable bridge structures. As one way to construct the highly durable and long lifetime concrete structures, it is considered that steel rebars and PC tendons are reduced in concrete structures. This paper describes development of high-strength fiber reinforced concrete (HSFRC), which is developed mainly to increase shear strength of the concrete. Not only does this HSFRC possess high shear strength due to high compressive strength and fiber reinforced, but it don’t also require peculiar curing methods and materials. The result of the examination, it was shown that it is possible to make HSFRC possess the specified workability, compressive strength of proportioning, 80-100 N/mm2, and high shear strength.

Saiyad Waquar Husain examined on strength and behavior of steel fiber reinforced concrete with fly ash for m30 grade using Steel fiber and fly ash are common additives that can improve concrete performance. The aim of study was to measure compressive strengths of concrete of M30 grade with different steel fiber percentages and fly ash percentages. Concrete specimens with fiber contents of 0.5, 1.0 and 1.5 % by weight were tested. Fly ash contents in mixes ranged between 0 to 15% by weight. Ninety concrete cubes prepared. A hydraulic testing machine was used to measure the compressive strength of each block. The result of this study confirmed that the additions of steel fiber and fly ash have improved the compressive strength of concrete.

A. A. Elsayed examined on Influence of Silica Fume, Fly Ash, Super Pozz and High Slag Cement on Water Permeability and Strength of Concrete with Increase in the replacement ratios for other mineral admixtures than ordinary Portland cement concrete. The main in this study, effects of mineral admixtures on water permeability and compressive strength of concretes containing silica fume (SF), fly ash (FA) and super pozz (SP) were experimentally investigated. Permeability of concrete was determined through DIN 1048 (Part 5). The research variables included cement type, ordinary Portland cement (OPC) or high slag cement (HSC), and mineral admixtures content was used as a partial cement replacement. They were incorporated into concrete at the levels of 5%, 10% and 15% for silica fume and 10%, 20% and 30% for fly ash or super pozz by weight of cement. Water-cement ratio of 0.40 was used and tests were carried out at 28 days. From the tests, the lowest measured water permeability values were for the 10% super pozz and 10% silica fume or 20% fly ash mixes. Cement concrete without admixtures. The optimum cement replacement by FA, SP and SF in this experiment was 10% SP. The knowledge on the strength and permeability of concrete containing silica fume, fly ash, super pozz and high slag cement could be beneficial in the utilization of these waste materials in concrete work, especially on the topic of durability.

III.SCOPE AND OBJECTIVE OF PRESENT WORK

3.1. SCOPE AND OBJECTIVE

The objective of the present work is to develop concrete with good strength, less porous, less capillarity so that durability will be reached. For this purpose it requires the use of different pozzolanic materials like Fly ash and silica fume along with fiber. So the experimental program to be undertaken;

- To reduce the impact of waste materials on environment.
- To find out the percentage use of admixtures feasible for construction.
- To determine the mix proportion with Fly ash and silica fume with fiber to achieve the desirable needs.
- To determine the water/ binder ratio, so that design mix having proper workability and strength.
- To investigate different basic properties of concrete such as compressive strength, splitting tensile strength, flexural strength

etc., and comparing the results of different proportioning.

- To determine the chloride penetration of concrete using Rapid Chlorine Penetration Test (RCPT).
- For safe construction, to find the how much percentage of silica fume and fly ash is partially replaced by cement and steel fibers as an admixture to attains strength at maximum level.

IV.OBJECTIVE OF PRESENT WORK MATERIALS AND EXPERIMENTAL STUDY

4.1 GENERAL

The physical and chemical properties of cement, fine aggregates, coarse aggregates and water used in this investigation are analyzed based on standard experimental procedure laid down in standard codes like Indian standard code, ASTMC, and Bureau of Indian standard codes.

4.2 MATERIALS

The materials used in present investigation include;

1. Cement-Ordinary Portland Cement (OPC)
2. Mineral Admixtures-
   a. Silica Fume and
   b. Fly-Ash
3. Fine aggregates
4. Coarse aggregates
5. Steel hook fibers as admixture and
6. Water

4.3 CEMENT

Ordinary Portland cement of 53 grades was selected for the experimental investigation. The compressive strength characteristics of cement were tested as per IS: 4031-1988 and IS: 12269-1987(9).The cement used in present study was Zuari cement. The experiments such as standard consistency, initial setting time, final setting time and specific gravity of cement are conducted on ordinary Portland cement.

TABLE 4.1 PHYSICAL PROPERTIES OF OPC

S.No	Characteristic of cement	Value	Code specifications (IS 4031-1988)
1	Fineness of cement	**94.76%**	**-**
2	Normal consistency	**33%**	**Not specified**
3	Initial setting Time	**40 minutes**	>30
4	Final setting time	**350 minutes**	<600
5	Specific gravity	**3.14**	-

The chemical composition of cement was analysed according to standard procedures laid down in IS 4301(part-5):1988.the results of analysis are presented in table 4.2.

TABLE 4.2 CHEMICAL COMPOSITION OF CEMENT

S.NO	Oxide	Present Content
1	CaO	65.49
2	SiO_2	21.67
3	Al_2O_3	5.97
4	Fe_2O_3	3.85
5	SO_3	1.66
6	MgO	0.78
7	K_2O	0.46
8	Na_2O	0.12

The percentage compositions of major compounds (known as BOGUE compounds) present in cement are tabulated below.

TABLE 4.3 THE PERCENTAGE COMPOSITION OF THE MAJOR COMPOUNDS PRESENT IN THE TEST CEMENT

S.No	Name of The Compound	Conversion Formulae	% present in Cement
1	Tri-Calcium Silicate ($3Cao.SiO_2$)	4.07(Cao)-7.60(siO_2)-6.72 (Al_2O_3)-1.43 (Fe_2O_3)-2.85(SO_3)	51.49
2	Di-calcium Silicate ($2Cao.SiO_2$)	2.87 (SiO_2)-0.754 (3 $Cao.SiO_2$)	23.37
3	Tri-calcium aluminate ($3CaO.Al_2O_3$)	2.65 (Al_2O_3)-1.69 (Fe_2O_3)	9.31
4	Tetra-calcium alumina ferrite ($4CaO.Al_2O_3.Fe_2O_3$)	3.04 (Fe_2O_3)	11.70

4.3.1 TESTS ON CEMENT

4.3.1.1 FINENESS OF CEMENT BY DRY SIEVING METHOD

The degree of fineness of cement is a measure of the mean size of grains in cement. The finer cement has quicker action with water and gains early strength through its ultimate strength remains unaffected. However, the shrinkage and cracking cement will increase with the fineness of cement. Apparatus used to determine the sieve analysis are I.S. Sieve No. 9 (90 Microns)**,** Weighing Balance capacity 5 kg as per **IS: 4031(part 1)-1996**.Weigh 100 grams of the given cement and sift it continuously for 15 minutes on IS. Sieve 9 no air set lumps may be broken down by fingers but nothing should be rubbed on the sieves. Find the weight of residue of the sieved after the sifting is over and report the values as a percent of the original sample taken.

4.3.1.2 NORMAL CONSISTENCY

About 400g of cement was initially taken and mixed with water, 00The paste was filled in the mould of Vicat's apparatus and care was taken such that the cement paste was not pressed forcibly in the mould and the surface of filled paste was smoothened and levelled. A square needle 1mm×1mm of size is to be attached to the plunger and then lowered gently on to the surface of the cement paste and is released quickly. As plunger pierces the cement paste, reading on scale was recorded. The experiment was performed carefully away from vibrators and the other disturbances. The test procedure was repeated by increasing the percentage of mixing water at 0.5% increment until the needle reaches 5 to 7 mm from the bottom of the mould. When this condition is fulfilled, the amount of water added was taken as the correct percentage of water for normal consistency. The entire test was completed within 3 to 5 minutes, if the time taken to complete the experiments exceeds 5 minutes, the sample was rejected and fresh sample was taken and the operation was repeated again. Fresh cement was taken for each repetition of the experiment. The plunger was cleaned each time the experiment is done.

The normal consistency of Cement sample prepared with different replacements of Fly ash (10%, 20% and 30%) is compared with Ordinary Cement. Both the initial and final setting time of Cement sample prepared with different replacement of Fly ash (10%, 20% and 30%) are compared with Ordinary Cement. If the difference is less than 30 minutes, the change is considered to be insignificant and it is more than 30 minutes, the change is considered to be significant

4.3.1.3 RESULTS OF NORMAL CONSISTENCY

Table 4.4 gives the result of normal consistency for different replacement percentages of Cement with Fly ash. Normal consistency test shows very slight increase in consistency of Cement for different dosages 0%, 10%, 20% and 30% of Fly ash in Ordinary Portland Cement.

TABLE 4.4 VARIATION OF STANDARD CONISTENCY FOR DIFFERENT REPLACEMENT PERCENTAGES OF CEMENT WITH FLY ASH

Sl. No	Mix Proportion	Standard Consistency (%)
1.	100%OPC + 0%FA	33
2.	90%OPC + 10% FA	34
3.	80%OPC + 20% FA	35
4.	70%OPC + 30% FA	36

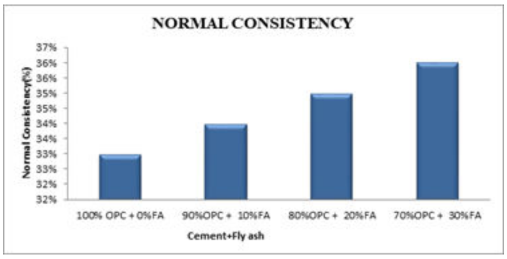


Fig 4.1 Normal Consistency for Replacement percentages of Cement by Fly Ash

SILICA FUME

Silica fume is a waste by-product of the production of silicon and silicon alloys. It is available in different forms, of which the most commonly used is in a dandified form. Silica fume used was conforming to IS: 1331(PART-1) 1992 and also ASTM C (1240-2000). Silica fume was also referred as micro silica or condensed silica fume, is a byproduct material that is used as a pozzolanic. This by product is a result of the reduction of high-purity quartz with coal in an electric arc furnace in the manufacture of silicon or ferrosilicon alloy. The use of silica fume will make concrete with the following properties (Sobolev and Batrakov, 2007):

- Low heat of hydration,
- Retarded alkali-aggregate reaction,
- Reduced freeze-thaw damage and water erosion,
- High strength,
- Increased sulfate resistance, and
- Reduced permeability.

TABLE 4.14.PHYSICAL AND CHEMICAL PROPERTIES OF SILICA FUME

Property	Results	Protocol
Color	Dark grey	ASTMC 1240
Practical size	<1μm	ASTMC 1240
Specific surface	15,000 to 30,000 m^2/kg	ASTMC 1240
Bulk density	695 g/cm^3	ASTMC 1240
Specific gravity	2.2	ASTMC 1240
Moisture content	0.78%	ASTMC 1240
Sio_2	92.83%	ASTMC 1240
K2o	0.26%	ASTMC 1240
Na2o	0.35%	ASTMC 1240
Fe2o3	0.87%	ASTMC 1240
Al2o3	0.69%	ASTMC 1240

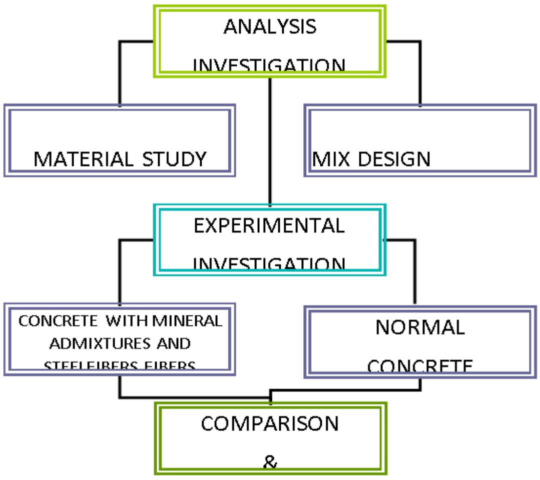
4.7. FLY ASH

For this project Fly ash is taken from Rayalaseema thermal power plant (RTPP), Kadapa. RTPP has installed ESP for segregation and collection of fly ash into six different fields. As the field number increases the fineness of fly ash increases but the quantity decreases. Field-1 fly ash has coarse particles and is not suitable for concrete applications. Since maximum availability of fly ash is from field-2, some of them was used for our study. This fly ash conforms to the requirements of **IS: 3812 part-I and also ASTMC-618 type-F.**

TABLE 4.15.PROPERTIES OF FLY ASH

Sl. No.	Characteristics	Percentage
1	Silica,SiO2	49-67
2	Alumina,Al2O3	16-28
3	Iron oxide,Fe2O3	4-10
4	Lime, CaO	0.7-3.6
5	Magnesia, MgO	0.3-2.6
6	Sulphur trioxide, SO3	0.1-2.1
7	Loss of ignition	0.4-0.9
8	Surface area,(m2/kg)	230-600
9	Specific gravity	2.3

V.METHODOLOGY



5.1 MIX-PROPORTIONS OF HSFRC FOR M60 GRADE

Mix Proportions:

	Water	Cement	Fine aggregate	Coarse aggregate
Proportion by Weight	147kg	420	650.916	1254.24
Proportion by Ratio	0.35	1	1.55	2.985

TABLE 5.1 MIX-PROPORTIONS FOR M60 GRADE CONCRETE THAT ARE USED IN HSFRC

Sample	Cement (%)	Silicafume (%)	Fly Ash (%)	F.A (kg/m^3)	C.A (kg/m^3)	W/C Ratio	Water (liters)	Steel fibers (% by volume of concrete)
Controlled mix	100	0	0	651	1254	0.35	147	0.5
10%SF +10%FA+0.5%SHF	80	10	10	651	1254	0.35	147	0.5
10%SF +020%FA+0.5%SHF	70		20	651	1254	0.35	147	0.5
10%SF +30%FA+0.5%SHF	60		30	651	1254	0.35	147	0.5
15%SF +10%FA+0.5%SHF	75	15	10	651	1254	0.35	147	0.5
15%SF +20%FA+0.5%SHF	65		20	651	1254	0.35	147	0.5
15%SF +30%FA+0.5%SHF	55		30	651	1254	0.35	147	0.5

Where SF=silica fume FA=fly ash
SHF=steel hook fibers

5.2 PREPARATION OF CONCRETE

Production of quality concrete requires meticulous care exercised at every stage of manufacture of concrete. It is interesting that the ingredients of good concrete and bad concrete are the same. If meticulous care is not exercised and good rules are not observed the resultant concrete is going to be of bad quality. With the same material if intense care is taken to exercise control at every stage it will result in good concrete.

5.3 TESTS CARRIED OUT ON FRESH CONCRETE

5.3.1 SLUMP CONE TEST

Slump cone test apparatus was made according to IS: 7320-1974 and used for calculating normal consistency of concrete Fresh concrete was filled in slump cone by tamping each layer for 25 times with a tamping rod. Later metal cone is raised slowly in a vertical direction. As soon as the settlement of concrete slump of the concrete measured by scale.

5.3.2 COMPACTION FACTOR TEST

Place the concrete sample gently in the upper hopper to its brim using the hand scoop and level it. Cover the cylinder and Open the trap door at the bottom of the upper hopper so that concrete falls in to the lower hopper .Push the concrete sticking on its sides gently with the road. Open the trap door of the lower hopper and allow the concrete to fall in to the cylinder below.

Cut of the excess of concrete above the top level of cylinder using trowels and level it. Clean the outside of the cylinder. Weight the cylinder with concrete to the nearest 10 g. This weight is known as the weight of partially compacted concrete (w1). Empty the cylinder and then refill it with the same concrete mixture in 3 layers approximately 5cm deep, each layer being heavily rammed to obtain full compaction. Level the top surface. Weigh the cylinder with fully compacted. This weight is known as the weight of fully compacted concrete (w2).Find the weight of empty cylinder (W)

Compaction Factor= (W1-W2 / W2-W)

5.4 TESTS FOR HARDENED CONCRETE

Testing of hardened concrete play an important role in controlling and conforming the quality of cement concrete works. Systematic testing of raw materials fresh concrete and hardened concrete are inseparable part of any concrete with regard to both strength and durability the test methods should be simple, direct convenient to apply one of the purposes of testing hardened concrete is to conform that the concrete used at site has developed the required strength. As the hardening concrete takes time, this is an inherent disadvantage in conventional test can be carried out to predict 3,7, 28,56,90 days strength but mostly when correct materials are used and careful steps are taken at every stage of the work, concrete normally the required strength. Tests are made by casting cubes or cylinder from representative concrete. It is to be removed that standard compressive test specimens give a measure of the potential strength of the concrete and not of the strength of the concrete structure. Knowledge of the strength of concrete is structure is cannot be directly obtained from tests on separately made specimens. The different types of tests conducted on concrete are

1 .Compressive strength test
2. Split tensile strength test
3. Flexural strength test

5.4.1 COMPRESSIVE STRENGTH TEST

Cubes with dimensions of 150mm×150mmx150mm are used for Compression test, durability test (acid). The size of the cylinder was 15 cm diameter and 30 cm length was used for Split tensile test. All these specimens were casted in cast iron moulds confirming to relevant codes of Indian standards. Prior to casting of specimen, moulds were cleaned, lubricated with oil and all the bolts are fastened tightly so that there is no leakages in the mould. The curing was done by immersing concrete specimens in a tank containing water. This method of curing is called as water curing by immersion. The concrete specimens were cured for specified number of days (3, 7, 28, 56 and 90 days) in water at 25± 2^0C and later specimens are taken out of water for testing.

Compressive Strength Testing Machine is used for the determination of compressive strength for cubes and cylinders. The specimens after subjected to curing drying for 1 day are loaded in compressive strength testing machine. It is able to provide compressive load up to 2000kN. When tested concrete cubes should fail by developing of a crack in body of cubes.

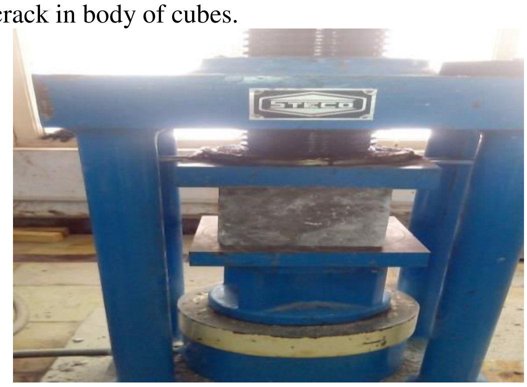


Fig 5.3: Cube compressive strength testing machine.

5.4.2 SPLIT TENSILE STRENGTH TEST

As per IS specifications **IS 5816:1999** Split tensile test is to be conducted. The cylinder of size is 150 mm diameter and 300 mm length are taken and cylinders were placed horizontally between the loading plate surfaces of a compression testing machine. Then the load was applied to the cylinder until failure of the vertical diameter along the cylinder length. The maximum load on the cylinder was to be observed. Cylindrical splitting tension test is also sometimes referred as "Brazilian test". This test was developed in Brazil in 1943. At about the same time this independently developed in Japan.

The test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of a compression testing machine and the load is applied until failure of the cylinder along the vertical diameter. When the load is applied along the generator an element on the vertical diameter of the cylinder is subjected to a vertical compressive stress

Split Tensile Strength = LOAD / AREA = 2P/ πDL

Where

P is the compressive load on the cylinder

L is the length of the cylinder
D is its diameter

The main advantages of this method is that the same type of specimen and the same testing machine as are used for the compressive test can be employed for this test, that is gaining popularity splitting test simple to perform and gives more uniform result than other tension tests. Strength determined in the splitting test is believed to be closer to that true tensile strength of concrete than the modulus of rupture. Splitting strength gives about 5-12% higher value than the direct tensile strength agreement with what is generally observed for conventional concrete. The presence of fibres again had little effects on the test results.

Fig 5.4: Split tensile test on cylinder

VI.RESULTS AND DISCUSSION

The results of present investigation are presented both in tabulated and graphical forms. In order to facilitate the analysis, interpretation of results is carried out at each phase of experimental study. This interpretation of the results obtained based on the current knowledge available in the literature as well as on the basis of results obtained. The significance of results is assessed with reference to the standards specified by the relevant IS codes.

Also durability of concrete during its service life may be significantly affected by the environmental condition to which it is exposed, and in order to produce a concrete of high quality, appropriate mix, curing system in a suitable to the environmental condition during the early stages of hardening. The durability test "Rapid Determination of the Chloride Permeability of Concrete was also being taken into consideration the cubes were cut in the size of 50mm width and 100mm diameter and were tested.

The cubes, cylinder and beams were taken tested 3, 7, 28, 56 and 90 days and results were obtained and the graphical views were shown in the below tabulations. By the results the calculations shows the increasing the compressive strength, split tensile strength, flexural strength.

This result shows the maximum addition of steel fibers and fly ash at the peak point this makes the maximum utilization of steel fibers and fly ash should be added to the concrete at certain intervals to attain the maximum strength.

6.1. COMPRESSIVE STRENGTH RESULTS:

The compressive strength of concrete for different replacements of cement with 10% and 20% of silica fume and 10%,20% and 30% of fly-ash with 0.5% steel hook fibres by volume of concrete were tested for 3,7,28,56 and 90 days using compressive test machine. The water to cement ratio was taken as 0.35. Three cubes were casted for each proportion and the average of three test samples was taken for the accuracy for results. At the room temperature, the concrete cubes were cured. The values of crushing loads obtained are taken and the compressive strength obtained are shown in table 6.1

TABLE 6.1.COPRESSIVE STRENGTH COMPARISION FOR ALL PROPORTIONS OF CONCRETE WITH 0.5% STEEL HOOK FIBRES AS ADMIXTURE

S. NO	SAMPLE	AVERAGE COMPRESSIVE STRENGTH				
		3 days	7 days	28 days	56 days	90 days
1	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

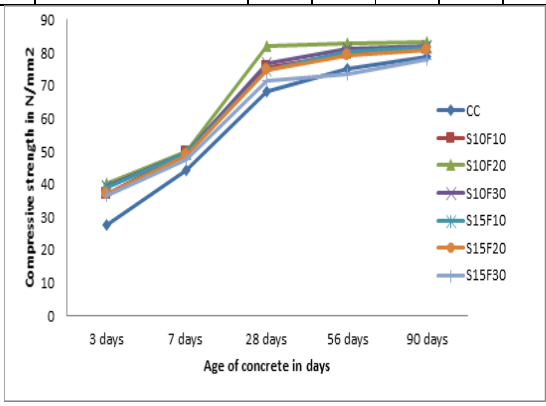


Fig No.6.1: Compressive Strength Comparison of All Proportions of Concrete with 0.5% steel hook fibers as admixture

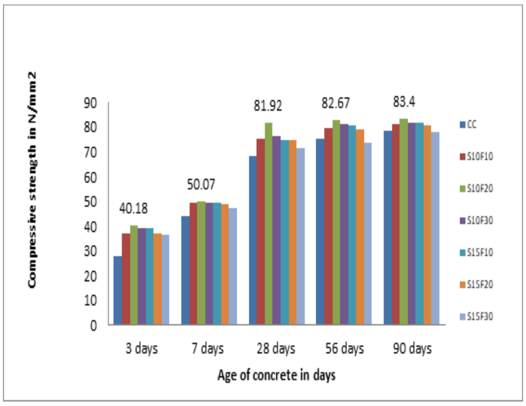


Fig No.6.2: Compressive Strength Comparison of All Proportions of Concrete

6.2 COMPRESSIVE STRENGTH COMPARISON OF DIFFERENT PROPORTIONS OF CONCRETES WITH COTROLLED CONCRETE:

CASE-I: Compressive strength comparison of controlled concrete with 10% Silica Fume and 10% fly ash replaced concrete with 0.5% steel hook fibers as admixture.

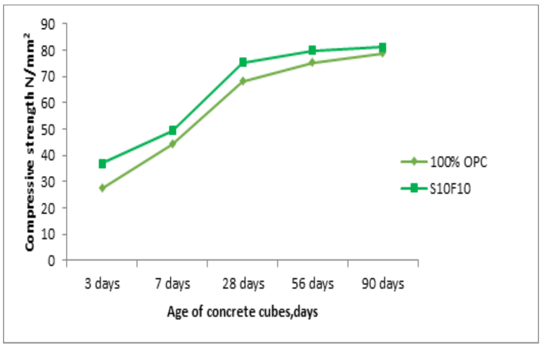


Fig 6.3: compressive strength comparison of controlled concrete with 10% silica fume and 10% fly ash replaced to cement with 0.5% steel hook fibres by volume of concrete.

The above graph shows the variation of compressive strength with increase in age of concrete. On comparing with controlled concrete, the compressive strength of concrete on replacing cement with 10% silica fume and 10% fly ash with 0.5% steel hook fibres as admixture shows higher results (green).The compressive strength of controlled concrete for 3,7,28,56 and 90 days are 27.62, 44.23, 68.07, 75.18 and 78.74 N/mm^2.

Compressive strength of concrete, increases with the addition of mineral admixtures. For this proportion (S10F10) the compressive strength variation for 3, 7, 28, 56 and 90 days are 36.96, 49.40, 75.33, 79.77 and 81.11 N/mm^2.At this proportion the compressive strength of concrete is increased by 10.7%.

CASE-2: Compressive strength comparison of controlled concrete with 10% Silica fume and 20% fly ash replaced concrete with 0.5% steel hook fibers as admixture.

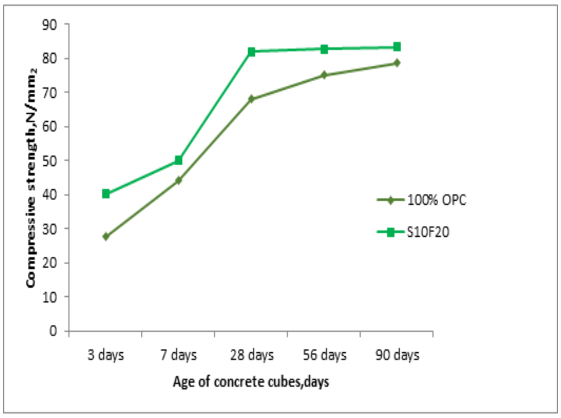


Fig 6.4: compressive strength comparison of controlled concrete with 10% silica fume and 20% fly ash replaced to cement with 0.5% steel hook fibres by volume of concrete.

The above graph shows the variation of compressive strength with increase in age of concrete. On comparing with controlled concrete, the compressive strength of concrete on replacing cement with 10% silica fume and 20% fly ash with 0.5% steel hook fibres as admixture shows higher results (green).The compressive strength of controlled concrete for 3,7,28,56 and 90 days are 27.62, 44.23, 68.07, 75.18 and 78.74 N/mm^2.

Compressive strength of concrete increases, with the addition of mineral admixtures. For this proportion (S10F20) the compressive strength variation for 3, 7, 28, 56 and 90 days are 40.18, 50.07, 81.92, 82.67 and 83.40 N/mm^2.At this proportion the compressive strength of concrete is increased by 20.34%.

This proportion gives the optimum compressive strength compared to all other proportions.

VII.CONCLUSION

Based on the results obtained from the present investigation the following conclusions were made;

1. By the addition of steel hook fibers in concrete leads to increase in compressive strength and makes concrete into ductile.
2. In split tensile and flexural tests, we notices that crack width reduced due to the presence of steel fibers when compared with conventional specimen.
3. When the cement is replaced with 10% silica fume and 20% fly ash gives the optimum compressive strength, split tensile strength and flexural strength.
4. At 10% silica fume and 20% fly ash replacement to cement, compressive strength were increased up to 20.34% when compared with conventional concrete for 28 days.
5. At 10% silica fume and 20% fly ash replacement to cement, split tensile strength were increased up to 60.85% when

compared with conventional concrete for 28 days.

6. At 10% silica fume and 20% fly ash replacement to cement, flexural strength were increased up to 38.74% when compared with conventional concrete for 28 days
7. The addition of silica fume and fly ash as replacement to cement, its normal consistency and initial setting time increases with increase in percentage and final setting time decreases with increase in percentage.
8. The use of mineral admixtures in concrete causes considerable reduction in the volume of large pores at all ages and thereby reduces the permeability of concrete mixes because of its high fineness and formation of C-S-H gel.

SCOPE OF FURTHER STUDY:

From the results it is conclude that the silica fume and fly ash are better replacements to cement. The rate of strength gain is high. After performing all the tests and analyzing the result, the following conclusions can be derived:

1. With decrease in W/C ratio strength of concrete increases.
2. Workability of concrete decreases as increase with % of silica fume and fly ash.
3. Compressive strength of concrete may increases when the cement replacement is below 10% of silica fume.
4. From literature it is observed that, the compressive strength of concrete increases with the percentage increase of steel hook fibers.
5. With the addition of chemical admixtures on reducing water content leads to increase in strength of concrete.
6. To produce High Strength/Performance Concrete with high ductility fibers are the critical elements which should be present in the design mix.

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