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Research Paper

INFLUENCE OF MINERAL ADMIXTURES ON THE MECHANICAL PERFORMANCE OF STEEL FIBER REINFORCED CONCRETE

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ABSTRACT

Concrete is mainly containing natural sand and gravel or crushed- rock aggregate and water, when placed in the skeleton of form and allowed to cure, becomes hard like stone. Generally weighing about 2400kg/m^3 is called "normal-weight concrete" and it is the most commonly used concrete for structural purposes. High strength concrete is concrete with a compressive strength higher than 40mpa. it is made by lowering the water-cement (W/C) ratio 0.40 or lesser . it had widely used in large and long life constructions that demands early age strength, high density, heat of hydration, high flow ability, and high durability. It is very difficult to get products which additionally fulfill all of the properties. So the different mineral admixtures like Ground Granulated Blast furnace Slag (GGBS), silica fume, Rice husk ash, Fly ash, High Reactive Met kaolin, are some of the admixtures which can be used in concrete as partial substitutement of cement, which are very important ingredients to make high strength concrete.

Our aim it is to study the properties of concrete by partially replacing cement by fly ash and silica fume

In this study, Cement was partially substituted by Fly Ash and silica fume. A mix design was done for M_{40} grade of concrete by using IS method. The utilization of fly-ash and silica fume in concrete as partial substitutement of cement. . Three grades of normal port land cement (OPC) namely: 33, 43 and 53 as classified by bureau of Indian Standard (BIS) or commonly used in construction industry**.** Now in this project only 53 grade of cement is used. This paper reports comparative study on effects of concrete properties by partially substitutement of OPC of 53 grade with fly ash and silica fume. We have to use the water falling admixture i.e. super plasticizer, which plays an important role for the production of high strength concrete. We have used steel fiber in different percentage i.e. 0.5%, 1%, 1.5% to that of total weight of concrete and casting was done. Lastly we used different percentages of silica fume with the substitutement of cement keeping constant fiber content and concrete was casted. We prepared concrete cubes and cylinders lastly compressive test, splitting test ,flexural test are conducted

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I. INTRODUCTION

1.1 GENERAL

Fiber reinforced concrete (FRC) is Portland cement concrete reinforced with more or less randomly distributed fibers. In FRC, thousands of little fibers are dispersed and distributed at random in the concrete during mixing, and thus get better concrete properties in all directions.

FRC is cement- based compound material that has been developed in recent years. It has been effectively used in construction with

its excellent flexural-tensile strength, resistance to spitting, impact resistance and excellent permeability and frost resistance. It is a successful way to raise toughness, shock resistance and resistance to plastic shrinkage cracking of the mortar. Fiber is a small part of reinforcing material possessing certain characteristics properties. They can be rounding, triangular or flat in cross-section. The fire is often described by a convenient parameter called ―aspect ratio. The characteristic ratio of the fiber is the ratio of its span to its diameter. The principle reason for incorporating fibers into a cement matrix is to raise the toughness and tensile strength and improve the cracking deformation characteristics of the resultant compound. For FRC to be a viable construction material, it must be able to complete cheaply with existing reinforced system.

Plain concrete possesses a very low tensile strength limited ductility and little resistance to cracking internal micro cracks are naturally present in the concrete and its poor tensile strength is due to the propagation of such micro cracks eventually leading to brittle fracture of concrete.

In the past, attempts have been made to impart development in tensile properties of concrete members by way of using conventional reinforced steel bars and also by applying restraining techniques. Although both these methods provide tensile strength of concrete members, they however, do not raise the inherent tensile strength of concrete itself.

In plain concrete and similar brittle materials, structural cracks (micro cracks) develop even before loading, mainly due to drying shrinkage or other causes of volume change. The breadth of these original cracks rarely exceeds little microns, but their other two sizes may be of superior magnitude.

1.2. CLASSIFICATION OF CONCRETE

The advent of concrete technology techniques has given impetus for making of concrete of high strength .as per our Indian standard IS 456:2000 concretes are groped as normal concrete, standard concrete and high strength concrete as given in table 1.1

Table 1.1 grouping of concrete as per IS 456:2000

SI.NO	Name of Group Of Concrete	Grade description
1	Normal concrete	M10 to M20
2	Standard concrete	M25 to M55
3	High strength concrete	M60 to M80
Note: M refer to mix and the number to specified compressive strength of 150 mm size cube at 28 days expressed in N/mm^2		

The American concrete institute (ACI) categories the concrete as normal strength concrete (NSC). High strength concrete (HSC) and ultra-high strength concrete (UHSC). As indicated in Table 1.2

Table 1.2 grouping of concrete as per ACI code

SI. NO	Name of Group Of Concrete	Concrete strength (Cylinder strength f'c)
1	Normal Strength Concrete(NSC)	21 Mpa to 42 Mpa
2	High Strength Concrete(HSC)	60 Mpa to 90 Mpa
3	Ultra High Strength Concrete(UHSC)	115 Mpa to 160Mpa

1.3. HIGH STRENGTH CONCRETE

Concrete is generally used as a Normal Strength Concrete (NSC), High Strength Concrete (HSC), and Ultra High Strength Concrete (UHSC), there are no clear cut boundary for the above classification .Indian Standard Recommended Methods of mix design denotes the boundary at 35 Mpa between NSC and HSC they did not talk about UHSC. But elsewhere the international forum, about 30 years ago the high strength label was applied to concrete having strength 40 Mpa more recently 50 to 60 Mpa in the world scenario last 15 years concrete of very high strength entered in the field, in particular construction of high rise buildings and long span bridges .concrete strength of 90 to 120Mpa are occasionally. Indian constructions concrete strength varying from 45 to 60 Mpa been used in high rise buildings .they have used High Strength Concrete 60 Mpa with silica fume as one of the constituents.

1.3.1. Production of High Strength Concrete in Practice

Concrete in practice is produced with more compressive strength. The production of high strength concrete will grow to find its due place in concrete construction for all the obvious benefits in the modern batching plants high strength concrete is produced in mechanical manner. Of course .one has to care about mix proportioning, controlled cements, shape of aggregates mineral admixtures and chemical admixtures low water cementations materials silica fume. With modern equipment's site quality control during production, transportation and placement. A specified workability of concrete can be obtained by adding super plasticizers.

1.3.2. Selection of Materials

It is necessary to get the maximum performance out of all of the materials involved in producing High Strength Concrete. The culmination of any mix design process must be the extensive testing of trial mixes. It is possible to achieve compressive strengths up to 100 Mpa using fly ash ,ground granulated blast furnace slag and to achieve strength beyond 100Mpa , the use of silica fume has been found to be essential , and it is frequently used for the production of High Strength Concrete.

1.3.3 Supplementary Cementing Materials for High Strength Concrete

High Strength Concrete contains at least one supplementary cementing materials i.e. fly ash; slag, or Silica fume. Very often, fly ash or slag is used in conjunction with silica fume.

1.3.4. Fly Ash

Fly ash also known as flue-ash is one of the residues generated in combustion coal and comprises the fine particles that rise with the flue gases. Ash which does not raise is termed bottom ash. In an manufacturing context, fly ash usually refers to ash produced during combustion of coal. Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal-fired power plants, and together with bottom ash removed from the bottom of the furnace is in this case jointly known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes considerable amounts of silicon dioxide (SiO_2) and calcium oxide (CaO).

1.3.4.1 Chemical Composition

In general, which contains more than 60% SiO2, and 28% Al2O3 by mass and source of fly ash influence its mineralogical composition. Due to the rapid cooling of burned coal in the power plant, fly ashes consist of noncrystalline particles (≤90%), or glass and a small amount of crystalline material. Depending on the system of burning, some unburned coal may be collected with ash particles. In adding to a substantial amount of glassy material, each fly ash may include one or more of the four key crystalline phases: quartz, mullite, magnetite, and hematite. In sub

bituminous fly ashes, the crystalline phases may include C3A, C4A3S, calcium sulphate, and alkali sulphates. Table 1.3 shows the chemical composition of some selected fly ashes. The reactivity of fly ashes is linked to the noncrystalline phase or glass. The reasons for the high reactivity of high-calcium fly ashes may lie partially in the chemical composition of the glass.

Table 1.3.The Chemical composition of Fly ash

Constituents	Percentage (%)
SiO_2	60.48
Al_2O_3	28.15
Fe_2O_3	4.52
Cao	1.71
K_2O	1.41
MgO	0.47
Na_2O	0.14
L.O.I	1.59

1.4. FIBER REINFORCED CONCRETE

1.4.1. Introduction

Fibers are generally used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also decrease the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce better impact abrasion, and shatter resistance in concrete. Normally fibers do not amplify the flexural strength of concrete, and so cannot substitute moment resisting or structural steel reinforcement. Indeed, some fibers

The amount of fibers added to a concrete mix is expressed as a percentage of the total volume of the composite (concrete and fibers), termed "volume fraction" (V_f). V_f typically ranges from 0.1 to 3%. The aspect ratio (l/d) is designed by separating fiber length (l) by its diameter (d). Fibers with a non-circular cross section use an corresponding diameter for the calculation of aspect ratio. If the fiber's modulus of elasticity is higher than the matrix (concrete or mortar binder), they help to carry the load by rising the tensile strength of the material. rising the aspect ratio of the fiber usually segments the flexural strength and toughness of the matrix. However, fibers that are too long tend to "ball" in the mix and make workability problems.

Some recent investigate indicate that using fibers in concrete has limited effect on the impact resistance of the materials. This finding is very important since conventionally, people think that ductility raise when concrete is reinforced with fibers. The results also indicate that the use of micro fibers offers better impact resistance to that of longer fibers.

1.4.2. History of Fibers

The idea of using fibers as reinforcement is not new. Fibers have been used as reinforcement since ancient times. Historically, horsehair was used in mortar and strawinmud bricks. In the 1900s, asbestos fibers were used in concrete. In the 1950s, the idea of compound materials came into being and fiber-reinforced concrete was one of the topics of interest. Once the health risks associated with asbestos were exposed, there was a need to find a substitutement for the matter in concrete and other building materials. By the 1960s, steel, glass (GFRC), and synthetic fibers such as polypropylene fibers were used in concrete. Research into new fiber-reinforced concretes continues today.

1.4.3. Effect of Fibers in Concrete

Fibers are regularly used in concrete to control cracking due to both plastic shrinkage and drying shrinkage. They also decrease the permeability of concrete and thus reduce bleeding of water. Some type’s offers produced greater impact, abrasion and shatter resistance in concrete. Generally fibers do not raise the flexural strength of concrete and so cannot substitute moment resisting or structural steel reinforcement. Indeed, some fibers actually reduce the strength of concrete. The amount of fibers added to the concrete mix is expressed as percentage of total volume of the composite

(concrete and fibers), termed volume fraction (Vf). VF typically ranges from 0.1 to 3%. Aspect ratio (l/d) is calculated by dividing fiber length (l) by its diameter (d). Fibers with a noncircular cross section use an equivalent diameter for the calculation of aspect ratio. If the modulus of elasticity of the fiber is advanced than the matrix (concrete or mortar binder), they help to take the load by growing the tensile strength of the material. Rise in the aspect ratio of their usually segments the flexural strength and the toughness of the matrix. However, fibers which are tooling tend to ―ball in the mix and create workability problems. Some recent research indicates that using fibers in concrete has limited effect on the impact resistance of the materials. This finding is very important since usually, people think that the ductility rises when concrete is reinforced with fibers. The results also indicated out that the use of micro fibers offers improved impact resistance compared with the longer fibers.

II. LITERATURE REVIEW

Some of the early research works had done using different pozzolanic materials with the substitutement of cement using super plasticizer for the development high performance concrete. Also the development in the field of fiber reinforced concrete along with mineral admixtures. So beneath an over view of different studies has been represented.

Aitkin [1] (1995) cited on development in the application of high performance concrete. Over the last few years, the compressive strength of some of concrete used has raised dramatically. In 1998, a 120 Mpa concrete was delivered on site, while, until relatively recently, 40 Mpa was considered indicative of high strength. The spectacular raise in compressive strength is directly related to a number of recent technical developments, in particular the discovery of the extra normal dispersing action of super plasticizers with which flowing concretes can be made with about the same mixing water that is actually required to hydrate all the cement particle or even less. The reduction in water/cement ratio results in the hydrated cement paste with a micro structure so dense and strong that coarse aggregate can become the concrete's weakest constituent. Silica fume, a highly reactive pozzolana, considerably enhances the paste/aggregate interface and minimizes deboning. Finally, the use of supplementary cementitious materials, such as fly ash and specially slag, helps resolve slump loss problems which become dangerous at low w/c ratios.

Ajdukiewicz and radomski [2] (2002) delve into trends in the polish research on high performance concrete. They analyzed the main trends in the research on high performance concrete (HPC) in Poland. There they sighted on some example of the relevant investigations. e fundamental engineering and economical problems concerning the structural applications if HPC in Poland are presented as well as the needs justifying the raised use of the this material are briefly described.

Aitkin[2](2003) studied on the durability characteristics of high performance concrete. He examined durability problems of normal concrete can be associated with the severity of the environment and the use of in appropriate high water/binder ratios. High performance concrete that have a water/binder ratio between 0.30 and 0.40 are regularly more durable than regular concrete not only since they are less porous, but also since their capillary and pore networks are somewhat detached due to the maturity of self-desiccation. In high-performance concrete (HPC), the infiltration of aggressive agents is quite hard and only superficial. However, self-desiccation can be very injurious if it is not prohibited through the early phase of the development of hydration reaction, therefore, HPC must be cured fairly another way from normal concrete. Field knowledge in the North Sea and in Canada has

shown that HPCs, when they are correctly designed and cured, execute adequately in very harsh environments. However, the fire resistance of HPC is not as good as that of normal concrete but not as bad as is occasionally written in a few negative reports. Concrete, whatever its type remains a safe material, from a fire resistance point of view, compared to other building materials

AI-khalaf and A. yousif (4) (1984) examined on use of RHA in concrete. They studied the actual range of temperature require to burn rice husk in order to get the desired pozzolanic product, use of rice husk as partial substitutement of cement on compressive strength and volume changes of different mixes. And showed that up to 40% substitutement can be complete with no significant modify in compressive strength compared with the organize mix. He tested on mortar cube, by testing on50mm cubes. In his investigation also he deduced that the most convenient and economical burning conditions required converting rice husk into a homogenous and well burnt ash is at 500^0c for 2 hours. Also for a given grinding time, there is a considerable reduction in the specific surface area of RHA content, the water requirement decreases as the fineness of the ash raises. The minimum pozzolanic activity can be obtained, when the ash has a specific surface of about 11,500 cm^2/gm. The strength of cement RHA mortar approaches the strength of the corresponding plain mortar when the specific surface of RHA about 17000cm^2/gm. For 1:2 and 1:3 mortar mixes of standard consistency the maximum percentage of rice husk ash that can be substituted by weight of cement without 60days strength being less than that of plain mortar was 30% and 40% respectively. Also he found higher the percentage or RHA, higher is the volume change charterstics corresponding to plain mortar.

III. MATERIALS AND METHODS

3.1. MATERIALS

The materials used in this present investigation are Normal Portland cement (53 grade), water, coarse aggregates, fine aggregates (sand, sag).In recent years, improvements in concrete properties have been achieved by blending cements with cementitious admixtures such as fly ash (FA),granulated blast furnace slag (GBFS). Incorporation of these materials in concrete mixes improves the durability concrete. The movement of aggressive substances such as chloride ions and carbon dioxide into concrete which are the main causes of deterioration of concrete structures that affect their integrity and long term serviceability life, is thus very much reduced. The deterioration of concrete is not a result of only aggressive agents, but the overall quality of concrete and also plays a major role. In view of this problem, a growing number of concrete structures are constructed or under construction with the use of cement substitutement materials. Therefore any attempt to alleviate the deterioration-risk implies producing good performance concrete capable of withstanding the harsh environmental conditions.

In this chapter, the materials and methods described together with their properties. In this the tests carried out on different concrete mixes, curative regimes, mix proportions and casting of specimens is discussed.

3.1.1 Fly ash (FA)

Fly ash is a by-product of the combustion of pulverized coal in power stations. It is a solid material extracted by electrostatic and mechanical means from the flue gases of furnaces fired with pulverized bituminous coal. During production of FA, the coal passes through the high temperature zone in the furnace and the carbon and volatile matter are burned off, whereas most of the mineral impurities, such as clays, quartz, and feldspar melt at high temperature. The fused matter is

quickly transported to low-temperature zones, where it solidifies as spherical particles of glass. Some of the mineral substance agglomerates forming bottom ash, but most of it flies out with the flue gas stream and is called "fly ash". This ash is subsequently removed from the gas by mechanical separator, electrostatic precipitators. Its main constituents are SiO2, AL2O3 and Fe2O3 with smaller quantities of other metal oxides, the chemical composition of fly ash.

Due to its unique mineralogical and granulometric characteristics, fly ash generally does not need any processing before use as a mineral admixture. Bottom ash is much coarser, less reactive and therefore requires fine grinding to develop a pozzolanic property. Average worldwide utilization of fly ash is about 15%, whereas in India, its utilization is form 2 to 5% only. In the present study Fly ash is collected from RTPP. It is conformed to grade1 of IS: 3812-1981.

The physical properties of fly ash are shown in the following table 3.1

Table: 3.1 Physical properties of fly ash

S.NO	DESCRIPTION	
1	Specific Gravity	2.5
2	Physical Form	Powder
3	Colour	Dark grey

3.1.2Silica fume

Silica fume is a by-product of silicon or Ferro-Silica industry and is 100 times finer than cement. A silica fume is also referred to as micro silica or strong silica fumes. It consists of amorphous silica and has high reactivity towards lime. The substitute level of silica fume is generally low at about 10%. When SF is used in concrete mix, its beginning affects the physical understanding of the system, particularly near the aggregate surface where porosity exists. Silica fume starts reacting at the early stage of hydration procedure. The pozzolanic action of silica fume reduces considerably the quantity and size of “CH” crystals in hydrated cement paste. This phenomenon along with low W/C ratio reduces the thickness of conversion zones and thus the preferential orientation of CH crystals is significantly reduced. All these result in more uniform, stronger conversion zone potential of micro cracking.

The silica fume used in all concrete mixes was obtained from Elkem Materials Limited. The chemical composition information is given in Table 3.2. It can be seen that the silica fume contains 85% silicon dioxide. The physical properties of Silica fume are shown in the following table 3.2

Table: 3.2 Physical properties of Silica fume

S.NO	DESCRIPTION	
1	Specific Gravity	2.2
2	Physical Form	Powder
3	Colour	Grey

3.1.3Water

Water is important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to structure the strength giving cement gel, the quantity and quality of water is essential to be looked into very carefully. Water presented in the Laboratory is used for mixing and curing. The locally available potable water, which is free

from concentration of acid and organic substances, is used for mixing the concrete. The specific gravity of water is taken as 1.00.

3.1.4. Cement

Cement may be described as a material with adhesive and cohesive properties that make it capable of bonding, mineral fragments into a compact whole. Most cement used today is Portland cement. This is carefully proportioned and specially processed combination of lime, silica, iron oxide and alumina. It is usually manufactured from limestone mixed with shale, clay. Properly proportioned raw materials are pulverized into kilns where they are heated to a temperature of 1300 to 1500˚C. The clinker is cooled and ground to fine powder with addition of about 3 to 5% of gypsum. The OPC (53 grade) used in the present work is of Zuari cement.

3.1.4.1. Odinary Portland Cement (53 grade)

Normal Portland Cement (OPC) is one of several types of cement being manufactured throughout the world, are some of the more commonly used. OPC is a compound of lime (Cao), silica (SiO_2), alumina (AL_2O_3), iron (Fe_2O_3) and sulphur trioxide (SO_3), Magnesium (MgO) is present in small quantities as an impurity associated with limestone. SO_3 is added at the grinding stage to retard the setting time of the finished cement. When cement raw materials containing the proper proportions of the essential oxides are ground to a suitable fineness and then burnt to incipient fusion in a kiln, chemical combination takes place, largely in the solid state resulting in a product aptly named clinker. This clinker, when ground to a suitable fineness, together with a small quantity of gypsum (SO_3) is Portland cement. In fact, cement powder is "nothing else" other than a combination of oxides of calcium, silicon, aluminum and iron. The cement used throughout the test program was Normal Portland Cement (OPC) of 53 grades confirming to IS 4031:1988 was used in the present study. The specific gravity of cement is taken as 3.0. The chemical and physical properties of cement are presented in following tables.

3.1.4.2. Chemical composition O.P.C

Although Portland cement consists essentially composed of four major oxides: lime (Cao), silica (SiO_2), alumina (Al_2O_3), and iron (Fe_2O_3) and also Portland cement contains small amount of magnesia (MgO),alkalies(Na2O and K2O), and sulfuric anhydrite (SO3).

Table 3.4: Chemical composition Limits of Oxides in Portland cement are given below

S.NO	Oxide Composition	Percent Content
1	Lime, Cao	63
2	Silica,SiO_2	20
3	Alumina,Al_2O_3	6
4	Iron oxide,Fe_2O_3	3
5	Magnesia, Mgo	1.5
6	Sulphur trioxide, SO_3	2
7	Potassium oxide,K_2O	1
8	Sodium oxide,Na_2O	1
9	Tricalcium silicate,C_3S	54.1
10	Dicalcium silicate,C_2S	16.6
11	Tricalcium aluminate,C_3A	10.8
12	Tetra calcium aluminoferrite,C_4AF	9.1

3.2 METHODS

Parameters tested in this study

- Normal consistency,
- Initial setting & Final setting time
- Soundness
- Workability
- Compressive strength
- Split tensile strength
- Flexural strength

3.2.1 TESTS ON CEMENT

3.2.1.1 Initial and Final Setting Time

Cement paste was prepared by mixing cement with 0.85 times appropriate mixing water required to give a paste of standard consistency. The stop watch was started at the instant the mixing water was added to the cement. After half-a-minute, the paste was thoroughly mixed with fingers for one minute. The mould resting on a nonporous plate was filled completely with cement paste and the surface of filled paste was leveled smooth with the top of the mould. The test was conducted at room temperature of 27 ± 2^0C at a relative humidity of 60%. The mould with the cement paste was placed in the Vicat's apparatus and the needle was lowered gently to make contact with the test block and was then quickly released. The needle thus penetrates the block and the reading on the graduated scale of Vicat's apparatus was recorded. The procedure was repeated until the needle fails to pierce the block by about 5 to 7 mm measured from the bottom of the mould. The stop button of stop watch was pushed down and the time was recorded which give the initial setting time. The cement paste was considered finally set when upon applying the needle gently to the surface of test block, the needle makes an immersion, but fails to penetrate and the time was noted which gives the final setting time. The needle was cleaned after every repetition and also care was taken such that there could not any vibrations.

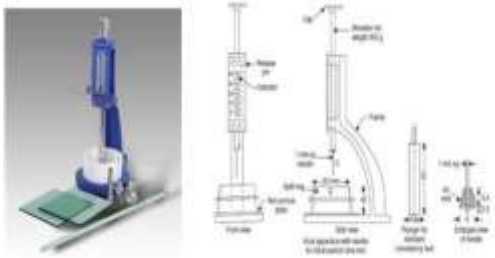


Figure: 3.1: Vicat apparatus with dimensions

3.2.1.2. Soundness

It consists of a small split cylinder of spring brass of 0.5mm thickness, forming a mould with 30mm internal diameter and 30mm high. On either side of the split are attached two indicators are attached with pointed ends AA, the distance from these ends to the Centre of cylinder being 165mm. the mould was placed on a glass sheet and was filled with cement paste formed by gauging 100g of cement with 0.78 times the mixing water required to give a paste of standard consistency. The mould was covered with a glass sheet and a small weight was placed on its top. The mould was then submerged in the water at a temperature of 27 ± 2^0C. After 24hours, the mould was taken out and the distance separating the indicators points was measured. The mould was again submerged in water. Using the water heaters the water was brought to boiling point within 25 to35 minutes and the specimen was kept for 3 hours at a boiling point. The mould was removed from water and was allowed to cool down to 27^0C. The distance between the indicator points was measured again. The difference between the two measurements represents the unsoundness of cement. For each concentration of mixing water, three samples were tested and the mean value was taken as the unsoundness of cement sample.

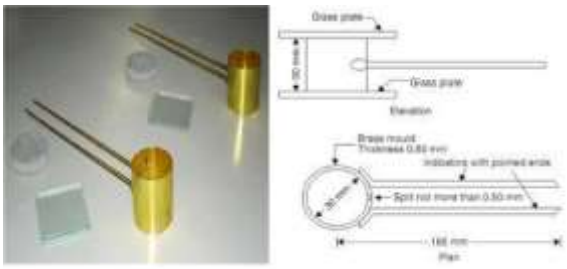


Figure: 3.2: Le Chatelier Apparatus with dimensions

3.2.1.3. Specific Gravity of Cement

Specific gravity of cement is defined as, the ratio of dry weight of cement to the weight of equal volume of kerosene added. This test is conducted by Le-Chatliers apparatus this property very important in the mix design. Note down the weight of empty density bottle (W_1). Take a one third of cement in bottle and weigh the bottle (W_2) then fill the bottle with kerosene fully and weigh the bottle with cement and kerosene (W_3). Then clean the bottle and fill the kerosene in the bottle and weigh the bottle with kerosene (W_4).

Note down the readings and determine the specific gravity of cement.

Specific Gravity of Cement = $(W_2-W_1)/((W_2-W_1)-(W_3-W_4))$



Figure 3.3: Specific gravity apparatus (Density bottle)

3.2.2. TESTS ON AGGREGATES

3.2.2.1. Sieve Analysis of coarse aggregate

Sieve analysis helps to determine the particle size distribution of the coarse and fine aggregate. This is done by sieving the aggregates as per IS: 2386 (Part I) – 1963. In this we use different sieves as standardized by the IS code and then pass aggregates through them and thus collect different sized particles left over different sieves. The apparatus used are a set of IS Sieves of sizes – 80mm, 63mm, 50mm, 40mm,31.5mm, 25mm, 20mm, 16mm, 12.5mm, 10mm, 6.3mm,4.75mm, 3.35mm, 2.36mm, 1.18mm, 600µm, 300µm, 150µm and 75µm. Balance or scale with an accuracy to measure 0.1 percent of the weight of the test sample. The sample for sieving should be prepared from the larger sample either by quartering or by means of a sample divider. The test sample is dried to a constant weight at a temperature of 110 + 5^oC and weighed. The sample is sieved by using a set of IS Sieves. On completion of sieving, the material on each sieve is weighed. Cumulative weight passing through each sieve is calculated as a percentage of the

total sample weight. Fineness modulus is obtained by adding cumulative percentage of aggregates retained on each sieve and dividing the sum by 100. The results should be calculated and reported as the cumulative percentage by weight of the total sample. The percentages by weight of the total sample passing through one sieve and retained on the next smaller sieve, to the nearest 0.1 percent. The results of the sieve analysis may be recorded graphically on a semi-log graph with particle size as abscissa (log scale) and the percentage smaller than the specified diameter as ordinate.

3.2.2.2. Specific Gravity of Coarse and fine aggregate

Obtain approximately 1000 g of aggregate material passing the (4.75 mm) sieve. Prepare the material. Dry the material until it maintains a constant mass. This indicates that all the water has left the sample. Drying should occur in an oven regulated at 230°F (110°C).Cool the aggregate to a comfortable handling temperature. Immerse the aggregate in water at room temperature for a period of 15 to 19 hours. Dry the sample to a saturated surface dry (SSD) condition. Spread sample on a flat, non-absorbent surface and stir it occasionally to assist in homogeneous drying. A current of warm air may be used to assist drying procedure .The air current (typically from a blow dryer) should not blow the sample off the non-absorbent surface. Throughout this drying process, the aggregate should be repeatedly tested for a SSD condition using the Cone Test as follows: Fill a cone-shaped metal mould to overflowing with drying aggregate. Lightly tamp the aggregate into the mould with 25 light drops of a small metal tamper Remove loose aggregate from the outside of the mould and carefully lift the mould vertically. If surface moisture is still present, the fine aggregate will retain its moulded shape. When theaggregate achieves an SSD condition, it will slump slightly. Upon the first test where slumping occurs, record the weight of the aggregate as SSD mass.



Figure 3.4: Specific gravity of fine and coarse aggregates apparatus

3.4. TESTS ON CONCRETE

3.4.1. COMPRESSIVE STRENGTH TEST

Remove the specimen from water after specified curative time and wipe out excess water from the surface. Take the dimension of the specimen to the nearest 0.2m. Clean the bearing surface of the testing machine. Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast. Align the specimen centrally on the base plate of the machine. Rotate the movable portion gently by hand so that it touches the top surface of the specimen. Apply the load gradually without shock and continuously at the rate of 140kg/cm2/minute till the specimen fails. Record the maximum load and note any unusual features in the type of failure.

Minimum three specimens should be tested at each selected age. If strength of any specimen varies by more than 15 per cent of average strength, results of such specimen should be rejected. Average of their specimens gives the crushing strength of concrete.



Figure 3.5: Compressive testing machine

3.4.2. SPLIT TENSILE TEST

The split tensile test were conducted as per IS 5816:1999. The size of cylinder is 300mm length with 150mm diameter. The specimens were kept in water for curative for 28, 60 and 90 days and on removal were tested in wet condition by wiping water and grit present on the surface. 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. The maximum load applied to the specimen was then recorded and the appearance of the concrete for any unusual features in the type of failure was noted. Average of three values was taken as the representative of batch. 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.

To find split tensile strength following equation has used. Figure 3 shows the testing of split tensile test.

Split tensile strength = $2P/(\pi DL)$

Where P=split tensile load, D=diameter of the cylinder



Figure 3.6: split tensile testing machine

3.4.3. FLEXURAL STRENGTH

For flexural strength test beam specimens of dimensions 15×15×70 cms were cast. The specimens were demoulded after 24 hours of casting and were transferred to curative tank where in they were allowed to cure for 7 days. These flexural strength specimen were tested under two points loading as per I.S.516-1959,over an effective span of 600mm divide into three equal parts and rest on flexural testing machine . The load raised &failure load is noted at cracking of beam specimen. In each category two beams was tested and their average valve is reported. The flexural strength was calculated as follows.

Flexural strength (Mpa)=$(P\times L)/(b\times d^2)$,

Where P=failure load, L=centre to centre distance between the support=600mm,b=width of specimen =150mm, d=depth of specimen=150mm.

IV. TEST AND RESULTS

GENERAL

Concrete is the most widely used manufactured material in the construction industry. It's the most important property is durability which relates the performance of the material to its service life under various environmental conditions. The ability of concrete to withstand and satisfactorily and for long periods the effects of load, time, and environment depends very much on how the engineering properties of the material are constituted initially and how they are allowed to develop with age.

The use of cementitious and pozzolanic siliceous industrial by-products as mineral admixtures-in concrete can bring improvements in engineering properties of concrete (strength, impermeability and general durability). Normal pozzolana additives due to their low surface area and reactivity are not generally able to improve the early strength which is crucial to the strength and stability of structural concrete applications and durability of concrete. The problem, though, could be solved by using a mixture of normal (such as fly ash and silica fume) and a highly reactive pozzolana, to produce a durable concrete which does not suffer from low early strength.

This interpretation of the results obtained is based on the current knowledge available in the

literature as well as on the results obtained. The significance of the results is assessed with reference to the standards specified by the relevant IS codes.

- The normal consistency of cement sample prepared with replacement of different mineral admixtures ranging from 5, 10, 15 and 20%.
- Both the initial and final setting time of cement sample prepared with replacement of different mineral admixtures ranging from 5, 10, 15 and 20% and are compared with ordinary cement. If the difference is less than 30 minutes, the change is considered to be insignificant and if it is more than 30 minutes, the change is considered to be significant.
- The sieve analysis of fine and coarse aggregate which is used for the present experimental work.
- The soundness of the cement with the partial replacements of mineral admixtures are determined.
- The workability test of fresh concrete was measured by the partial replacements of mineral admixtures.
- The average compressive strength of concrete of at least three cubes (150*150*150 mm) prepared with mineral admixture under consideration is compared with that of three cubes prepared with ordinary cement (for 7 days, 28 days,and 45 days).
- The average split tensile strength of concrete of at least three cylinders prepared with mineral admixture under consideration is compared with that of three cylinders prepared with ordinary cement (for 7,28and 945days).

5.2 RESULTS OF NORMAL CONSISTENCY TEST

5.2.1 Normal consistency of cement with replacement of fly ash

The variation of normal consistency of cement paste with addition of fly ash is shown in the table 5.1. The normal consistency test shows a very slight increase with the partial replacement of cement by fly ash at different dosages of 5, 10, 15, and 20 % in ordinary Portland cement which are 2% respectively.

Table 5.1: Variation of Normal consistency with replacement of fly ash

S.NO	Details of Material	Normal Consistency (%)
1	100% cement + 0% FA	32
2	95% cement +5% FA	34
3	90% cement +10% FA	34
4	85% cement +15% FA	34
5	80% cement +20% FA	34

5.2.2 Normal consistency of cement with replacement of silica fume

The variation of normal consistency of cement paste with addition of silica fume is shown in the

table 5.2. The normal consistency test shows a very slight increase with the partial replacement of cement by silica fume at different dosages of 5, 10, 15, and 20 % in ordinary Portland cement which are 2% and 4% respectively.

Table 5.2: Variation of Normal consistency with replacement of silica fume

S.NO	Details of Material	Normal Consistency (%)
1	100% cement + 0% SF	32
2	95% cement +5% SF	34
3	90% cement +10% SF	34
4	85% cement +15% SF	36
5	80% cement +20% SF	36

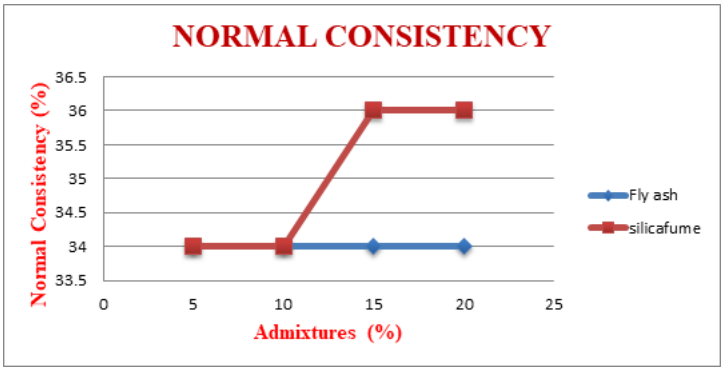


Figure 5.1: Effect on Normal Consistency for replacement of Cement with different admixtures

From figure 5.1 it can be seen that the percentage of water required for producing a cement paste of Standard Consistency is increasing with the increase in the amount of admixtures, when used as a partial replacement of cement. The Standard Consistency of normal cement is 32%. The Consistency value increases up to 38% at a replacement percentage of 20 with respect to the Consistency value of normal cement paste.

5.3. RESULTS OF INITIAL AND FINAL SETTING TIME

5.3.1 Initial and final Setting time of cement with replacement of fly ash

The variations in the initial and final setting times of cement with addition of fly ash. From table 5.3 it is observed that both the initial and final setting times got retarded and accelerated by replacement of fly ash in the ordinary Portland cement.

Table 5.3: Initial and Final setting time values cement with replacement of fly ash

S.NO	Details of Material	Initial Setting Time	Final Setting Time

		(minutes)	(minutes)
1	100% cement + 0% FA	45	300
2	95% cement +5% FA	50	300
3	90% cement +10% FA	60	290
4	85% cement +15% FA	70	280
5	80% cement +20% FA	70	260

5.3.2 Initial and final Setting time of cement with replacement of silica fume

The variations in the initial and final setting times of cement with addition of silica fume. From table 5.4 it is observed that both the initial and final setting times got retarded and accelerated by replacement of silica fume in the ordinary Portland cement.

Table 5.4: Initial and Final setting time values cement with replacement of silica fume

S.NO	Details of Material	Initial Setting Time (minutes)	Final Setting Time (minutes)
1	100% cement + 0% SF	45	300
2	95% cement +5% SF	45	340
3	90% cement +10% SF	45	340
4	85% cement +15% SF	50	330
5	80% cement +20% SF	50	310

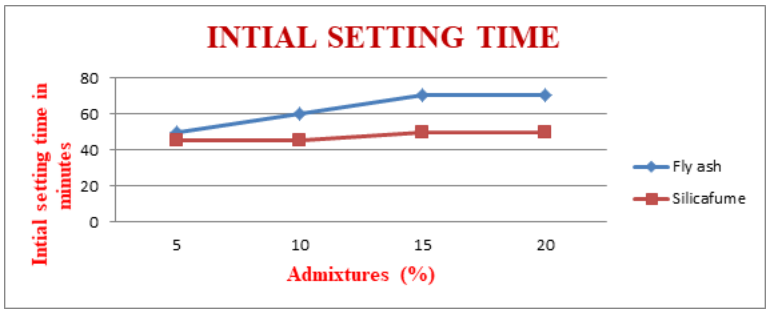


Figure 5.2: Effect on initial setting time for replacement of cement with different Admixtures

From above results it can be known that the initial setting time of normal cement paste is 45 minutes. From figure 5.2 the initial setting time was found to increase as the replacement percentage increases after the replacement of 5%. As per the Indian standards, the initial setting time should not be less than 30 minutes. Here all the replacement percentages satisfy this requirement**.**

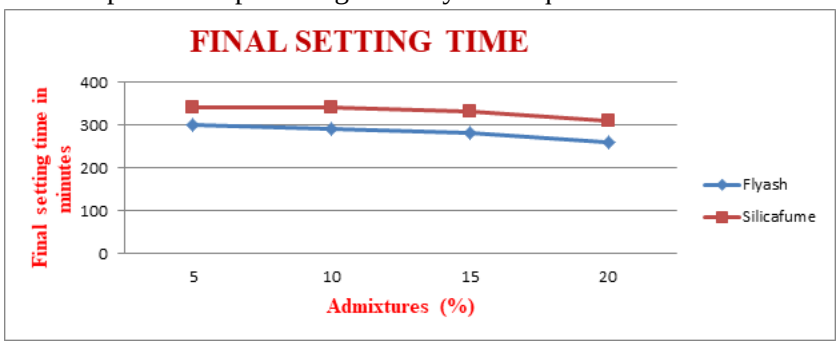


Figure 5.3: Effect on final setting time for replacement of cement with different admixtures

From above results it can be known that the final setting time of normal cement paste is 300 minutes. From figure 5.3 the final setting time was found to decrease as the replacement percentage increases after the replacement of 5%, as per the Indian standards, the final setting time should not be more than 600 minutes. Here all the replacement percentages satisfy this requirement.

5.4: SOUNDNESS TEST

The expansion of cement specimen was less than 10 mm specified by IS 4031(Part 3)-1988. This confirmed that the cement is a good additive material. Table 5.5 shows the values for soundness of 100% OPC.

Table 5.5: Soundness of Ordinary Portland cement

Test for Physical Requirement	**O.P.C 53 Grade**	**IS 4031-1988**
Lechatlier Method(mm)	1	<10

5.4.1 Soundness of cement with replacement of fly ash

The Le-Chatelier soundness tests were performed on the paste to assess the possibility of deleterious expansion due to the hydration of uncombined calcium oxide and/or magnesium oxide. No evidence of significant possible late expansion was found. The mortar soundness (expansion) for fly ash

composite cement indicates shrinkage increase. Increase in soundness with addition of fly ash can be explained by the relative increase in volume of reaction products.

TABLE 5.6: Soundness of cement with replacement of fly ash

S.NO	Details of Material	Expansion in mm
1	95% cement +5% FA	1
2	90% cement +10% FA	1.5
3	85% cement +15% FA	1.7
4	80% cement +20% FA	2

5.4.2 Soundness of cement with replacement of silica fume

The Le Chatelier soundness tests were performed on the paste to assess the possibility of deleterious expansion due to the hydration of uncombined calcium oxide and/or magnesium oxide. No evidence of significant possible late expansion was found. The mortar soundness (expansion) for silica fume composite cement indicates shrinkage increase. Increase in soundness with addition of silica fume can be explained by the relative increase in volume of reaction products.

Table 5.7: Soundness of cement with replacement of silica fume

S.NO	Details of Material	Expansion in mm
1	95% cement +5% SF	1
2	90% cement +10% SF	1.5
3	85% cement +15% SF	1.7
4	80% cement +20% SF	2

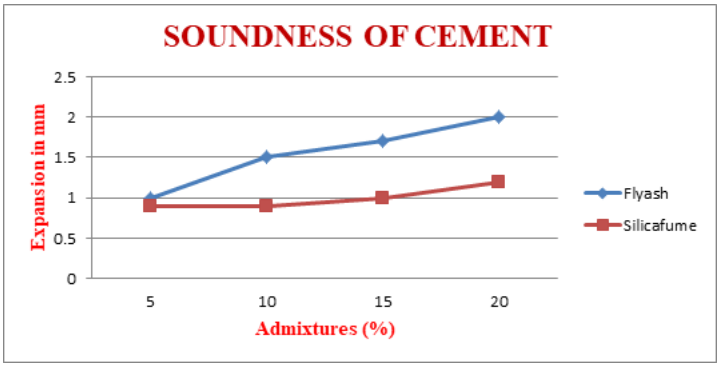


Figure 5.4: Soundness of Cement with replacement of different admixtures

As per IS 4031(Part 3)-1988 the expansion of cement specimen was specified by less than 10 mm. From figure 5.4 the soundness of cement was found to increase as the replacement percentage increases after the replacement of 5% to 20 %.As per the Indian standards, here all the replacement percentages satisfy this requirement.

5.5. FRESH CONCRETE TEST RESULTS

The properties of fresh concrete can be evaluated by slump cone test & compaction factor test with w/c ratio 0.4. The results of properties are given in table 5.8.

Table 5.8: Result of slump, compaction factor and density of fresh concrete

S.No.	Mix type (SF %,SF&FA%)	Slump value(mm)	compaction factor
01	MS0(0.0%,0.0%&0.0%)	72	0.952
02	MS1(0.5%,5%&5%)	20	0.820
03	MS2(0.5%,10%&10%)	35	0.810
04	MS3(0.5%,15%&15%)	48	0.902
05	MS4(1.0%,5%&5%)	15	0.801
06	MS5(1.0%,10%&10%)	16	0.786
07	MS6(1.0%,15%&15%)	31	0.802
08	MS7(1.5%,5%&5%)	12	0.740
09	MS8(1.5%,10%&10%)	13	0.792
10	MS9(1.5%,15%&15%)	15	0.810

V. CONCLUSIONS

The study on the effect of steel fibers with Fly Ash and silica fume can still be a promising work as there is always a need to overcome the problem of weakness of concrete. The following conclusions could be drawn from the present research.

1. Marginal raise is observed in the workability as percentage of Fly Ash and silica fume rises.
2. Density of concrete is more as the proportion of steel Fiber raises.
3. Compaction factor is raises as the Steel Fiber proportion decreases.
4. Higher percentage of Steel Fibers slump was down.
5. Water falling agent is required for workable mix as percentage of Steel Fiber raises.
6. Stiffness of specimens is raised because of Steel Fibers, Fly Ash and silica fume.
7. The strength of specimen is about 82% at 28th day and 95 to 100% at 45 days, because of steel fibers, Fly Ash and silica fume.
8. Specimen of MS1, MS4&MS7 having high Flexural strength as well as Compressive strength.
9.specimen number MS4 having high split tensile strength compare to normal concrete.
10. For small quantity of Fly Ash and silica fume (10%&20%) Compressive Strength is more for 1.0% & 1.5% Steel Fibers.

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