IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 21, Issue 4, Ser. II (Jul - Aug 2019), PP 52-63
www.iosrjournals.org

An Experimental study on strength properties of Hyper Concrete

K. Amulya[1], R. Aneesh[2]
[1]*M.tech student Roll no- 17961D8715, Lenora Engineering College, Rampa chodavaram, E.G.Dist, AP, India.*
[2]*Assistant Professor, Department of Civil Engineering, Lenora Engineering College,Rampachodavaram, E.G.Dist, AP, India.*
Corresponding Author: K. Amulya

Abstract: *Concrete as a construction material is widely used in India with annual consumption exceeding 100 million cubic meters. Conventional Ordinary Concrete which is designed on the basis of compressive strength does not meet many functional requirements since it is found deficit in aggressive environments conditions, time of construction, energy absorption capacity, repair and retrofitting jobs etc. So, there is a need to design High Performance Concrete (HPC) which is far superior to conventional concrete. High Performance Concrete exceeds the properties and constructability of normal concrete. These specially designed concretes are made up of normal & special materials which enable it to meets the general performance requirements in a particular structure. Special mixing, placing, and curing methodologies may be required in order to produce such type of concrete. When the general performance of concrete is substantially higher than that of normal type concrete, such concrete is regarded as high performance concrete. High-performance concrete has been primarily used in the construction of tunnels, bridges, pavements, high rise building structures because of its strength, durability, and high modulus of elasticity. High Performance Concrete has received increased attention in the development of infrastructure such as buildings, industrial structures, hydraulic structures, bridges, highways etc. leading to utilization of large quantity of concrete. This work presents the general introduction of high performance concrete, its categorization, its composition and its applications in various civil engineering constructions.*

Date of Submission: 26-07-2019 Date of Acceptance: 12-08-2019

I. Introduction

1.1 GENERAL

Concrete is widely used for making architectural structures, foundations, brick walls, pavements, bridges/over passes, motorways/roads, runway sparking structures, dams and pools/reservoirs of all the above purposes it can be widely used for construction purposes. Its usage in construction has been increased rapidly from time. Concrete owes its unique position as the structural material to the fact, that it is economically highly resistant to fire, wind, water, and earthquakes .In the recent times its use in construction has been increased considerably due to the rapid development of cities and towns. The demand is likely to increase in the future to match the rapid industrialization, growing population, housing, transportation, and other factors.

Due to the advancement in the technology the usage of the concrete along with their partial replacements have done a new revolution. Scientists, engineers and technologies, are continuously on the look-out for the materials that can act as substitute for conventional materials and which can be used along with the concrete, so that the structure can be built economically.

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. However on many occasions individual materials as such may not serve the specific purpose. There have been so far many attempts to develop new materials, which is the combination of the two or more materials. Such materials are called composite materials. Concrete can be regarded as a composite material. For reducing the cost of concrete, greater use of pozzolanic materials was suggested.

Already investigations have been made by partial replacement of fly ash, marble powder and blast furnace slag in place of cement. Studies have been revealed that fly ash concrete have less strength when compared to conventional concrete, but with the use of super plasticizers in addition will not only compensate deficiency in its strength, but also modifies its properties. Partial replacement of cement with marble powder is allowed up to 10%. As cement is the costliest ingredient in the concrete, so it will be economical to replace cement other than aggregates when they are compared in cost. So we are investigating to replace cement with silica fume as it resembles cement in fineness, colour, and water absorbing properties.

Silica fume can be used either as a dandified or unidentified powder, a slurry, as a combination at the concrete mixer, or part of a factory-blended cement. Silica fume in concrete mix improves properties of the concrete that may not be achievable through the use of Portland cement alone. The resulting concrete mix becomes strong, durable and economical and also eco-friendly as it utilizes an Ecological hazardous material. Addition of silica fume to concrete improves the durability of concrete through reduction in the permeability, refined pore structure, leading to a reduction in the diffusion of harmful ions, reduces calcium hydroxide content which results in a higher resistance to sulphate attack. Improvement in durability will also improve the ability of silica fume concrete in protecting the embedded steel from corrosion.

1.2 CONCRETE

Concrete *is* a mixture of four materials which are Portland cement, water, fine aggregate (sand) and coarse aggregate (gravel or crushed stone). Concrete hardening is not caused by evaporation or drying but as results from a chemical reaction which is hydration between Portland cement and water. The history of the concrete can be traced back as early as the third century B.C. where the Romans used it to construct temples and other buildings where the concrete was made from lime, broken stones and sand. Concrete is the most widely used man made construction in the world. It is obtained by mixing compendious materials, water, aggregate, and sometimes admixtures in required proportions. Fresh concrete or plastic concrete is freshly mixed material which can be moulded into any shape hardens into a rock-like mass known as concrete. The hardening is because of chemical reaction between water and cement, which continues for long period leading to stronger with age.

The utility and elegance as well as the durability of concrete structures, built during the first half of the last century with ordinary Portland cement (OPC) and plain round bars of mild steel, the easy availability of the constituent materials of concrete and the knowledge that virtually any combination of the constituents, leads to a mass of concrete having a bred contempt. Strength was emphasized without a thought on the durability of the structures. As a consequence of the liberties taken, the durability of the concrete and concrete structures is on a southward journey; a journey that seems to have gained momentum on its path to self-destruction. This is particularly true of concrete structures which were constructed since 1970 or there about by which time (a) the use of high strength rebar's with surface deformations started becoming common,(b) significant changes in the constituents and (c) engineers started using supplementary compendious materials and admixtures in concrete, often without adequate consideration. The ordinary Portland cement (OPC) is one of the main ingredients used for the production of concrete and has no alternative in the civil construction industry. .

As our aim is to develop concrete which does not only concern on the strength of concrete, it also having many other aspects to be satisfied like less porous, capillary absorption, durability. So for this, we need to go for the addition of pozzolanic materials along with super plasticizer with having low water cement ratio. The use of silica fume is many, which is having good pozzolanic activity and is a good material for the production high performance concrete. Also now-a day's one of the greatest application in various structural fields is fibre reinforced concrete, which is getting popularity because of its positive effect on various properties of concrete.

1.3 SILICA FUME:

Very fine non crystalline silica produced in electric arc furnaces as a by-product of the production of elemental silicon or alloys containing silicon; also known as condensed silica fume or micro silica**.** Smoke by-product from furnaces used in the production of ferrosilicon and silicon metals amorphous silica with high SiO2 content, extremely small particle size, and large surface area highly reactive pozzolanic used to improve mortar and concrete. Silica fume, also referred to as micro silica or condensed silica fume, is a by-product 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. Silica fume rises as an oxidized vapour from the 2000°C (3630°F) 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.

The American Concrete Institute (ACI) defines silica fume as "very fine non-crystalline silica produced in electric arc furnaces as a by-product of the productions of elemental silicon or alloys containing silicon". It is usually a gray recolored powder, somewhat similar to Portland cement or some fly ashes. Silica fume is usually categorized as a supplementary cementations material. This term refers to materials that are used in concrete in addition to Portland cement. Silica fume is a by-product of producing silicon metal or ferrosilicon alloys in smelters using electric arc furnaces. These metals are used in many industrial applications to include aluminium and steel production, computer chip fabrication, and productions of silicones, which are widely used in lubricants and sealants. While these are very valuable materials, the by-product silica fume is of more importance to the concrete industry.

It is usually a grey coloured powder, somewhat similar to Portland cement or some fly ashes. It can exhibit both pozzolanic and cementations properties. Silica fume has been recognized as a pozzolanic admixture that is effective in enhancing the mechanical properties to a great extent. Addition of silica fume to concrete improves the durability of concrete, compressive strength of concrete, abrasion resistance, reduces permeability and also in protecting the embedded steel from corrosion. Fixed silica fume content of 7.5% to 8.5%Produced from as-produced densified or pelletized silica fume. Portland cement-silica fume blend is primary product one blend of silica fume and Portland cement now being marketed. Silica Fume physical effect is the presence of any type of very small particles will improve concrete properties. This effect is termed either "particle packing" or "micro filling". The carbon black and plain cement mixes showed comparable strength sat both 7 and 28 days, even though the carbon black mixes contained 10percent less cement (by mass) physical mechanisms do play a significant role, particularly at early ages. Chemical effects of silica fume simply effective pozzolanic material.

II. Literature Review

2.1 GENERAL

Extensive research works both at National and International level has been done on the use of various admixtures in mortars and concrete's with a common goal.

- To combat the environmental hazards from the industrial wastes.
- To modify the properties of traditional concrete to the desired level suitable to the specific circumstances.
- To conserve the natural resources used in the production of construction materials.
- To bring down the increasing cost economics of cement, building blocks and high strength concrete.
- To reduce the cost of concrete construction
- To achieve certain properties in concrete more effectively than by other means
- To maintain the quality of concrete during the stages of mixing, transporting, placing, and curing in adverse weather conditions
- To overcome certain emergencies during concreting operation.

In India, only government educational and research institutions and construction departments are responsible for research while in advanced countries, the most remarkable breakthrough have been achieved by the building material industries and their R&D laboratories. An accepted fact is that these encouraging results on the use of admixtures are not penetrating into the user community and the entire research work is getting flocked at their organization. With the result the very purpose of research work is questioned along with R&D units. The policy maker and consultants should take more interest in handling these issues directly keeping not only the techno economics in view but also national obligations.

2.2 REVIEW

Advance concrete technology can reduce the consumption of natural resources and energy sources thereby lessen the burden of pollutants on environment. We describe the feasibility of using the electric furnace waste in concrete production as partial replacement of cement with silica fume. Silica fume is sold in powder form but is more commonly available in a liquid. Silica fume is used in amounts between 10% and 100% by mass of the total cementious material. Hence various proportions may be replacement in the concrete such as Silica fume shall be made which corresponds to the replacement value of the silica fume up to 100% and the corresponding tests were done and the results were manipulated. The specimen shall be made for each sample for testing at 28 days. Additional samples may be required for various purposes such as to determine the strength of concrete at 3 days & 7 days or at the time of striking the formwork, or to determine the duration of curing, or to check the testing error.

Additional samples may also be required for testing errors.

- **Yogendran et al. (1987)** made an attempt to modify the properties of concrete with respect to its strength and other properties by using silica fume and chemical admixtures. They concluded that optimum replacement of cement by silica fume for high strength is found to be 15% for a water cementious ratio of 0.34 at all age.
- **Alhozaimy, A.M., et al (1995)** carried out experimental investigations on the effects of adding low volume fractions (<0.3%) of calculated fibrillated polypropylene fibres in concrete on compressive flexural and impact strength with different binder compositions. They observed that polypropylene fibres have no significant effect on compressive (or) flexural strength, while flexural toughness and impact resistance showed increased values. They also observed that positive interactions were also detected between fibres and pozzolans

- **Handongyan, Wei Sun, Husiu Chen (1999)** in their investigation, the impact and fatigue performance of high-strength concrete (HSC), silica fume high strength concrete (SIFUHSC), steel fibre high strength concrete (SFR HSC), and steel fibre silica fume high strength concrete (SSF HSC) under the action of repeated dynamic loading were studied. The mechanisms by which silica fume and steel fibres, reduce the damage were investigated.
- **Brooks et.al. (2000)** after studying the effect of silica fume, Metakaolin, fly ash and ground granulated blast furnace slag on setting times of high strength concrete, they concluded that there was increase in the retarding effect up to 10% replacement of cement by Metakaolin and as the percentage replacement is increased, the retarding effect is reduced.
- **Shannag (2000)** designed and studied very high compressive strength of 69 to 110MPa along with incorporation of locally available natural pozzolana and silica fume. He concluded that 15% replacement of cement with silica fume along with 15% natural pozzolan gave relatively higher strength than without natural pozzolan.
- **Juenger et al. (2004)** studied the alkali-silica reactivity of large silica fume derived particles. They reported that under accelerated testing agglomerated silica fume decrease expansion when used as a 5% replacement of reactive sand.
- **Langan et al. (2010)** studied the effect of silica fume on the heat of hydration of Portland cement. Silica fume was added as a partial replacement of cement at 10% by weight of the total cementious material. Calorimeter tests were performed on these mixtures at water/cementious ratios (w/cm) of 0.35, 0.40 and 0.50, up to a period of 24 h. However, several were carried on for 72 h to observe any later reactions. Effect of silica fume on the accumulative heat of hydration is shown in Table 2.4. It is evident that the presence of silica fume increased heat evolution during the first 30 min of hydration, and during the period from 8 to 24 h regardless of the w/cm ratio. Heat evolved during the dormant period remained almost constant for all mixtures, while the heat during the period from 2 to 8 h was reduced. Total heat evolved at 1 and 3 days was not changed by the presence of silica fume at w/c ratio of 0.35. Total heat at 1 day does increase with an increase in w/cm.
- **Meland** observed that cumulative heat evolved is lower when paste containing silica fume and lingo sulfonate. In addition, the higher the amount of silica fume, the smaller the amount of heat evolved. In the presence of lingo sulfonate, the hydration reaction was retarded and less heat was evolved from paste containing silica fume.

III. Materials USED

3.1 CEMENT

In the most general sense of the word, cement is a binder, a substance that sets and hardens independently, and can bind other materials together.

The word "cement" traces to the Romans, who used the term opus caementicium to describe masonry resembling modern concrete was made from crushed rock with burnt lime as binder. The volcanic ash and pulverized brick additives that were added to the burnt lime to obtain a hydraulic binder were later referred to as cementer, cimentum, cament, and cement.

Cement used in construction is characterized as hydraulic or Non hydraulic. Hydraulic cements (e.g., Portland cement) harden because of hydration, chemical reactions that occur independently of the mixture's water content; they can harden even underwater or when constantly exposed to wet weather.

The chemical reaction that results when the anhydrous cement powder is mixed with water produces hydrates that are not water soluble. Non-hydraulic cements (e.g. gypsum plaster) must be kept dry in order to retain their strength. The most important use of cement is the production of mortar and concrete, which is a combination of cement and an aggregate to form a strong building material that is durable in the face of normal environmental effects.

3. 2 SILICA FUME

Silica fume, also referred to as micro silica or condensed silica fume, is a by product material that is used as a pozzolan. 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. Silica fume rises as an oxidized vapour from the 2000°C (3630°F) 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.

3.3 ADVANTAGES OF SILICA FUME IN CONCRETE

- Increased cohesiveness of the fresh concrete, which can lead to improved handling characteristics.
- Curing can start earlier as there is no need to wait for bleed water to dissipate. (Bleeding is a form of segregation where the solid components of the concrete settle downwards, leaving water on the top surface. It continues until the cement paste has stiffened enough to end the settling process)

- High early strength (in excess of 25 N/mm2 at 24 hours).
- Lower permeability and improved durability (due to the fine particle size and reactivity of silica fume)
- Greater resistance to abrasion and impact than conventional concretes of similar strength grade
- Compressive strengths in excess of 60 N/mm2 are easily achieved. Higher flexural strength and modulus of elasticity than conventional concretes of equal compressive strength
- Silica fume can be used as an ingredient in high performance concretes containing micro-fibres to combat explosive spalling during exposure to fire. A properly designed silica fume high performance concrete containing micro-fibres with a low water/cement ratio will outperform conventional concretes in terms of resistance to spalling during fire (ACI 216)
- Environmental benefits (due to reduced cement contents and improved service life).
- Silica fume is a by-product of producing silicon metal or ferrosilicon alloys in smelters using electric arc furnaces. These metals are used in many industrial applications to include aluminum and steel production, computer chip fabrication, and production of silicones, which are widely used in lubricants and sealants.
- Silica fume significantly improves the properties of fresh and hardened concrete. The material's potential use was known as early as the late 1940s. But it wasn't widely used until the development of powerful dispersants, or high-range water reducing admixtures, or super plasticizers. Once these admixtures became available, using silica fume in concrete became possible.
- Fresh concrete made with silica fume is more cohesive and therefore less prone to segregation than concrete without silica fume. Too offset this increased cohesion when placing, silica fume concrete is typically placed at 40 to 55 mm greater slump than concrete without silica fume in the same placement.
- Also, because of the very high surface area of the silica fume and the usually very low water content of silica fume concrete, there will be very little, if any, bleeding. Once silica fume content of about 5% is reached, there will be no bleeding in most concretes.
- In addition to improved durability, the lack of bleeding allows a more efficient finishing process to be used with silica fume concrete flatwork.
- **Improve the protection of reinforcement Corrosion**:

In a marine structure, the performances of the concrete in terms of sulphate resistance must be taken into consideration for concrete design but the resistance to chlorides diffusion through the concrete is generally a main concern as well. Some studies conducted in several countries proved that Type 1 cements (with high C_3A content) blended with Silica fume used in combination with a high range water reducer provide high durable performance against chloride induced reinforcement corrosion and against sulphate attack.

- Improve the sulphate resistance of concrete.
- Improve the mechanical performances of concrete.

3.4 INFLUENCE OF SILICA FUME IN CONCRETE

The American concrete institute (ACI) defines silica fume as very fine non crystalline silica produced in electric arc furnaces as a by-product of production of elemental silicon or alloys containing silicon. Silica fume is also known as micro silica, condensed silica fume, volatized silica or silica dust. It is usually a grey coloured powder, somewhat similar to Portland cement or some fly ashes. It can exhibit both pozzolanic and cementations properties. Silica fume has been recognized as a pozzolanic admixture that is effective in enhancing the mechanical properties to a great extent. Addition of silica fume to concrete improves the durability of concrete, compressive strength of concrete, abrasion resistance, reduces permeability and also in protecting the embedded steel from corrosion.

Because of its extreme fineness and high silica content, silica fume is a very effective pozzolanic material. Standard specifications for silica fume used in cementations mixtures are ASTM C1240, EN 13263. Silica fume is added to Portland cement concrete to improve its properties, in particularly compressive strength, bond strength, and abrasion resistance. These improvements stem from both the mechanical improvements resulting from addition of a very fine powder to the cement paste mix as well as from the pozzolanic reactions between the silica fume and free calcium hydroxide in the paste. Addition of silica fume also reduces the permeability of concrete to chloride ions, which protects the reinforcing steel of concrete from corrosion, especially in chloride-rich environments such as coastal regions and those of humid continental roadways and runways (because of the use of deicing salts) and saltwater bridges.

Prior to the mid-1970s, nearly all silica fumes were discharged into the atmosphere. After environmental concerns necessitated the collection and land filling of silica fume, it became economically viable to use silica fume in various applications, in particular high performance concrete. Effects of silica fume on different properties of fresh and hardened concrete include.

3.5 WORKABILITY

With the addition of silica fume, the slump loss with time is directly proportional to increase in the silica fume content due to the introduction of large surface area in the concrete mix by its addition. Although the slump decreases, the mix remains highly cohesive.

3.6 SEGREGATION AND BLEEDING

Silica fume reduces bleeding significantly because the free water is consumed in wetting of the large surface area of the silica fume and hence the free water left in the mix for bleeding also decreases. Silica fume also blocks the pores in the fresh concrete so water within the concrete is not allowed to come to the surface.

3.7 SUPERPLASTICIZER

There are two types of admixtures i.e. Mineral admixtures and Chemical admixtures.

1) Mineral Admixtures:

- Metakaolin
- Ground granulated blast furnace slag
- Rice husk ash
- Fly ash

2) Chemical Admixture:

- Accelerating admixture
- Retarding admixture
- Water-reducing admixture
- Air entering admixture
- Super- plasticizing admixture

3.8 Super Plasticizing Admixture

It is a substance which imparts very high workability with a large decrease in water content (at least 20%), for a given workability. A high range water reducing admixture (HRWRA) is also referred as

Super plasticizer, which is capable of reducing water content by about 20 to 40 percent has been developed. These can be added to concrete mix having a low to-normal slump and water cement ratio to produce high slump flowing concrete. The effect of Super plasticizers lasts only for 30to 60 minutes, depending on composition and dosage and is followed by rapid loss in workability. One of the important factors that govern the issue water–cement ratio during the manufacture of concrete, lower the water-cement ratio lower will be the capillary pores and hence lower permeability and enhanced durability.

Although Super plasticizers are essential to produce a truly high performance concrete (HPC) characterized by low water-cement ratio and workability level without high cement content. Concrete is being produced with w/c ratio of as low as 0.25 or even 0.20 enabled the production of highly durable high performance concrete. The workability also increases with an increase in the maximum size of aggregate. But smaller size aggregate provides larger surface area for bonding with the mortar matrix, which increases the compressive strength. For concrete with higher w/c ratio use of larger size aggregate is beneficial. High range super plasticizer was used in all the concrete mixes to achieve good workability. Super plasticizers are added to reduce the water requirement by 15 to 20% without affecting the workability leading to a high strength and dense concrete. To achieve the uniform workability, the admixture dosage was adjusted without changing the unit water content. This ensured the identical W/C ratio for a particular cementious content and the effect of pozzolanic material replacement can directly be studied on the various properties of concrete.

3.9 Advantages of Water Reducing Admixture

- By the addition of admixture with the reduction in water cement ratio, a concrete having the same workability and greater compressive strength can be obtained.
- By adding of the admixture with no decrease in water cement ratio a concrete having same compressive strength but greater workability can be obtained.
- With the addition of admixture, a concrete with same workability and compressive strength can be obtained at lower cement content.

IV. Theoretical Aspects And Experimental Set Up

4.1 OBJECTIVE OF TESTING

It was proposed to investigate the behaviour of concrete in which cement is partially replaced with silica fume and it is compared with the nominal mix.

4.1.1 Experimental Set Up

In this stage collection of materials required and the data required for mix design are obtained by specific gravity test. Specific gravity tests are carried out for fine and coarse aggregate. The various materials used were tested as per Indian standard specifications.

Raw materials required for the concreting operations of the present work are

- Cement
- Silica Fume
- Coarse aggregate
- Fine aggregate

4.2 CEMENT

Table 4.1 Physical Properties of ordinary Portland cement of ANJANI-53 Grade

S.NO.	PROPERTY.	TEST RESULTS.
1	Normal consistency	32%
2	Specific gravity	3.13
3	Initial setting time	105 minutes.
	Final setting time.	520 minutes.
4	Soundness (Expansion) Lechatlier method	2 mm
5	Fineness of cement (Dry sieving method)	98%
6	Compressive strength cement at 7 days	31.6 N/mm^2
	28 days.	22.9 N/mm^2

4.3 SILICA FUME

Specific Gravity of silica fume = 2.21

4.4 FINE AGGREGATE (SAND)

Specific Gravity of Sand = 2.62

4.5 COARSE AGGREGATE

Specific Gravity of Coarse Aggregate = 2.64

4.6 WATER

Water to be used in the concrete work should have following properties:

- It should be free from injurious amount of oil, acids, alkalis or other organic or inorganic impurities.
- It should be free from iron, vegetable matter or other any type of substances, which likely to have adverse affect on concrete or reinforcement.
- It should be quite satisfactory for drinking purpose which is used in mixing of concrete.

4.7 MACHINERY AND EQUIPMENT

- Weight of balances of 1 gm accuracy and 0.01 gm accuracy, one plat form
- Compaction factor and slump apparatus.
- Curing tank.
- Specific gravity bottle.
- Pycnometer.
- Spring balance.
- Trowels and Tamping rods.
- Concrete moulds of 150x150x150.
- weighing balance.

4.8 PROCESS OF MANUFACTURE OF CONCRETE

4.8.1 Aggregates

The coarse aggregate was kept completely immersed in clean water for 24 hours for water absorption. After 24 hours, the aggregate was gently surface dried with dry cloth. It was then spread out and exposed to the atmosphere until it appears to be completely surface dry. For fineaggregate, considering the huge time to be taken to become surface dry from wet condition, it was not immersed in water. Instead the water was sprinkled then it was spread out and exposed to the atmosphere until it appears to be completely surface dry.

4.8.2 Batching

The quantities of cement, fly ash, fine aggregate, coarse aggregate and water for each batch were measured by a weighing balance of an accuracy of 1 gm.

4.8.3 Mixing:

The object of mixing is to coat the surface of all aggregate particles with cement paste and to blend all the ingredients of concrete in to a uniform mass. Thorough mixing of the materials is essential for the production of uniform concrete. The mixing should ensure that the mass becomes homogeneous, uniform in colour and consistency. Two methods are adopted for mixing concrete, Hand mixing and Machine mixing. In this study the process of mixing the materials has been done by hand mixing.

4.8.4 Casting of Concrete Cubes

The test moulds are kept ready before preparing the mix. Moulds are cleaned and oiled on all contact surfaces then fixed on vibrating table firmly. The concrete is filled into moulds in layers and then vibrated. The top surface of concrete is struck off level with a trowel. The number and date of casting are put on the top surface of the cubes.

4. 9 WORKABILITY TESTS

4.9.1 Slump Cone Test

Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work.

Actual slump height = 30 cms

Remove the cone the slump height = 26.5 cms

Slump value = 30-26.5= 3.5 cms = 35 mm

4.9.2 Compaction Factor Test

Compaction factor measures the workability in an indirect manner by determining the degree of compaction achieved by a standard amount of work done by allowing the concrete to fall through a standard height.

. **Compaction factor** the ratio of Weight of partially compacted concrete / to weight of fully compacted concrete is defined as Compaction factor.

Empty weight of cylinder (w_1) = 686 grams

Mass of partially compacted concrete (w_2) = 15284 grams

Mass of fully compacted concrete (w_3) = 16878 grams

Compaction factor = 0.905

4.10 COMPACTING

The test cube specimens are made as soon as practicable after mixing and in such a way as to produce full compaction of the concrete with neither segregation nor excessive laitance. The concrete is filled into the mould in layers approximately 5cm deep. In placing each scoopful of concrete. In order to ensure a symmetrical distribution of the concrete with in the mould. Each layer is compacted by either by hand or by vibration. After the top of the layer has been compacted the surface of the concrete is brought to the finished level with top of the mould, using a trowel, the top is covered with a glass or a metal plate to prevent evaporation.

4.10.1 Compacting By Hand

When compacting by hand, the standard tamping bar is used and the strokes of the bar are distributed in a uniform manner over the cross section of the mould. The number of strokes per layer required to produce the specified conditions vary according to the type of concrete. In no case should the concrete be subject to less than 35 strokes per layer for 15cm or 25 strokes per layer for 10 cm cubes. For cylindrical specimens, the numbers of strokes are not less than thirty per layer. Fly ash replacement material (FA) of design mixes compaction of cubes, cylinders, beams and all regular mix for beams was hand compacted.

4.11 CURING

The test specimens were stored in a place free from vibration and covered with wet gunny bags for 24 hours from the time of addition of water to the dry ingredients. After this period, specimens are removed from the moulds and immediately submerged in curing tank and kept there until taken out just period to rest. The water of curing tank was renewed or every seven days and maintained at a temperature of 27± 2 /^{0}C.

4.12 TESTS FOR COMPRESSIVE STRENGTH OF CONCRETE

In this study, the compression testing machine having capacity of 1000KN was used for compressive strength of the concrete cubes.

Calculations

The measured compressive strength of the specimen shall be calculated by dividing the maximum load applied to the specimen during the test by the cross sectional area calculated from mean dimensions of the section and shall be expressed to the nearest kg/cm^2, average of all values shall be taken as the representation of the batch provided and individual variation is not more that -15percent of average.

4.13 TESTS FOR ACCELERATED CURING OF CONCRETE

It is used to get early high compressive strength in concrete. This method is also used to find out 28 days compressive strength of concrete in 28 hours. (As per IS 9013-1978-Method of making, curing and determining compressive strength of accelerated cured concrete test specimens).

Accelerated curing is useful in the prefabrication industry wherein high early age strength enables the removal of the formwork within 24 hours thereby reducing the cycle time resulting in cost saving benefits.The most commonly adopted curing techniques are steam curing at atmospheric pressure, warm water curing, boiling water curing and autoclaving.

2. Cover the specimens with flat steel cover plate to avoid distortion during the use.
3. Carefully and gently lower the specimens into the curing tank and shall remain totally immersed for a period of 3½ Hours $\pm$ 15 min.
4. The temperature of water in the curing tank shall be at boiling (100 ^{o}C) when the specimens are placed.
5. After curing for 3 ½ hours in boil water, the specimen shall be carefully removed from the boiling water and cooled by immersing in cooling tank at 27 $\pm 2^o$C for 2 hrs.
6. After cooling remove the specimens from the mould and tested for its accelerated compressive strength (Ra) in N/mm^2.

7. The 28 days can be found out using following formula.

Predicted 28 days compressive strength = R28 = 8.09 + 1.64 Ra

where Ra is accelerated compressive strength

and R28 is predicted compressive strength at 28 days

V. CONCRETE MIX DESIGN

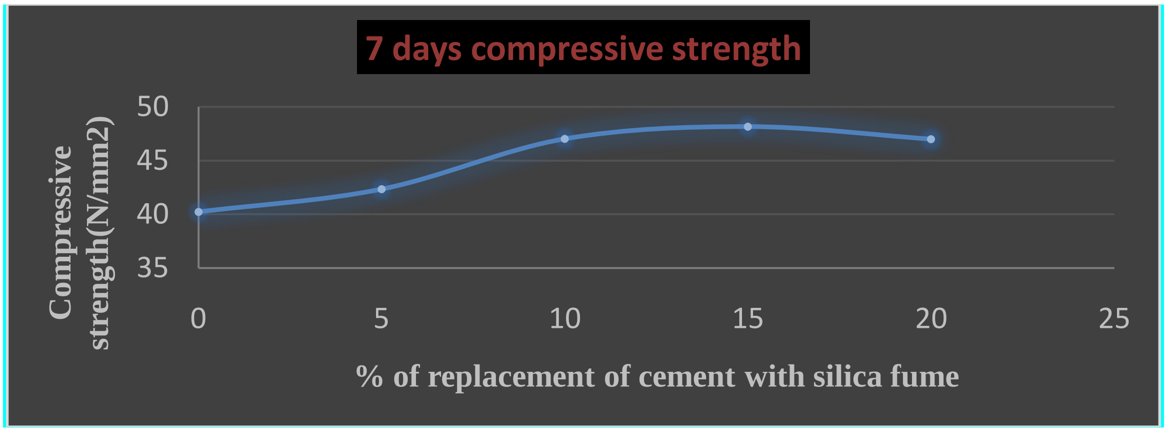
Silica replacement in %	w/c	Cement (kg)	Fine aggregate (Kg)	Coarse aggregate (kg)	Water (lit)	Super plasticizer(lit)	Silica (kg)
0	0.35	500	720	1044	169	5	0
5	0.35	475	720	1044	169	5	25
10	0.35	450	720	1044	169	5	50
15	0.35	425	720	1044	169	5	75
20	0.35	400	720	1044	169	5	100

V. Results And Discussions

6.1 COMPRESSIVE STRENGTH VALUES FORREPLACEMENT OF CEMENT BY SILICA FUME

Table 6.1 7-Days Compressive Strength Results

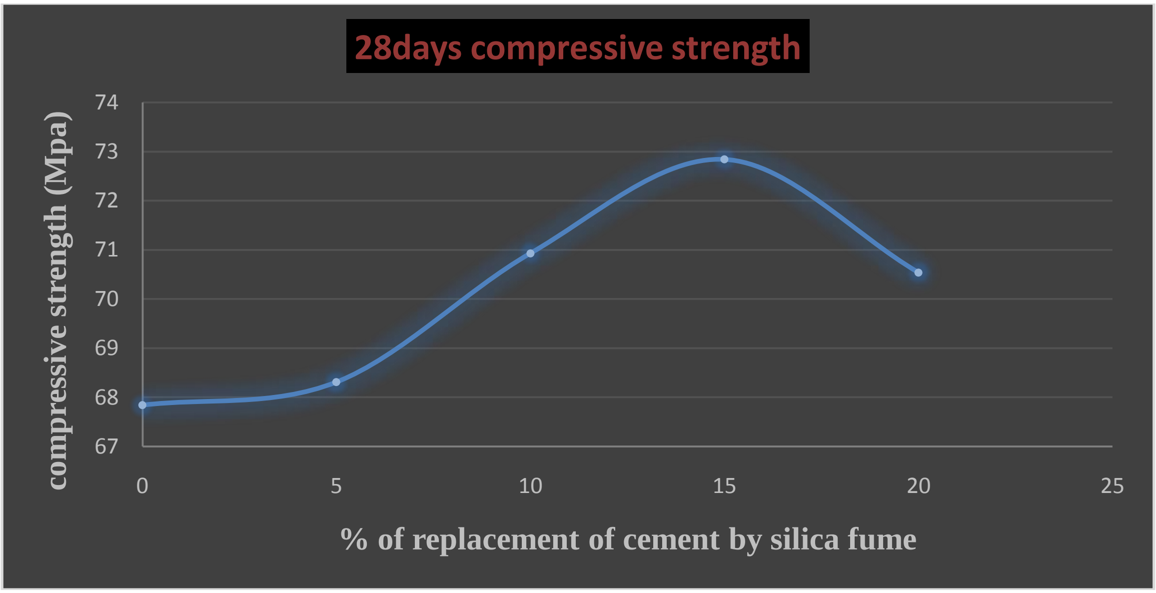
S.No	Total Replacement By silica fume (%)(Mix)	Compressive strength (Mpa)
1	0	40.22
2	5	42.34
3	10	47.02
4	15	48.16
5	20	47.1



Plot 6.1.7Days Compressive Strength

Table 6.2 28-Days Compressive Strength Results

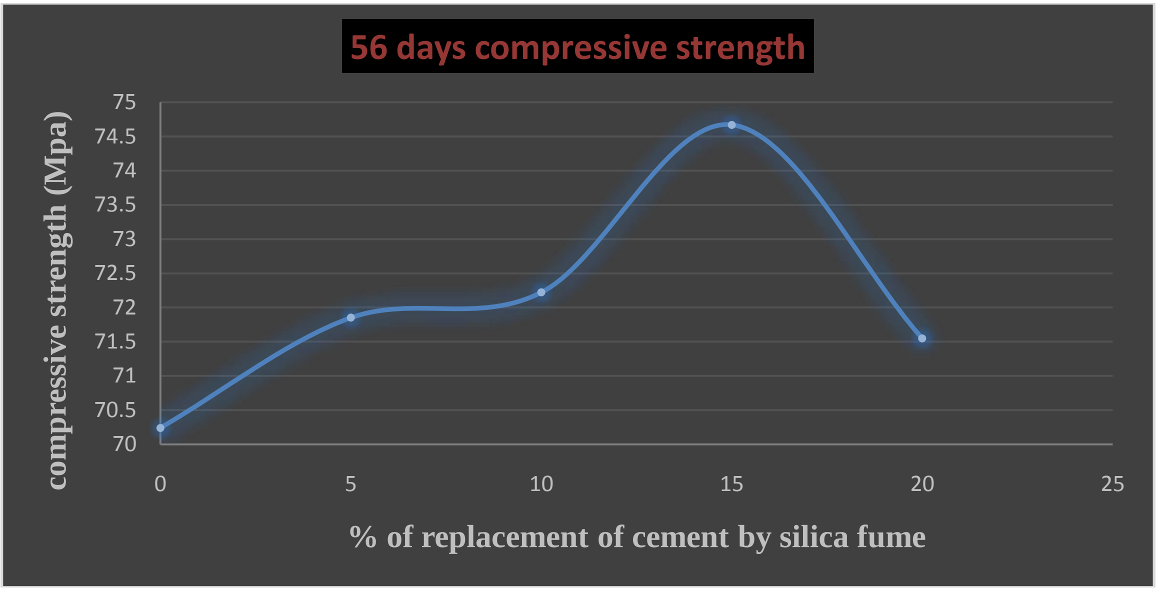
S.NO	Total Replacement By silica fume (%)(Mix)	Compressive strength (Mpa)
1	0	67.84
2	5	68.31
3	10	70.93
4	15	72.84
5	20	70.54



Plot 6.2. 28 Days Compressive strength

Table 6.3 56-Days Compressive Strength Results

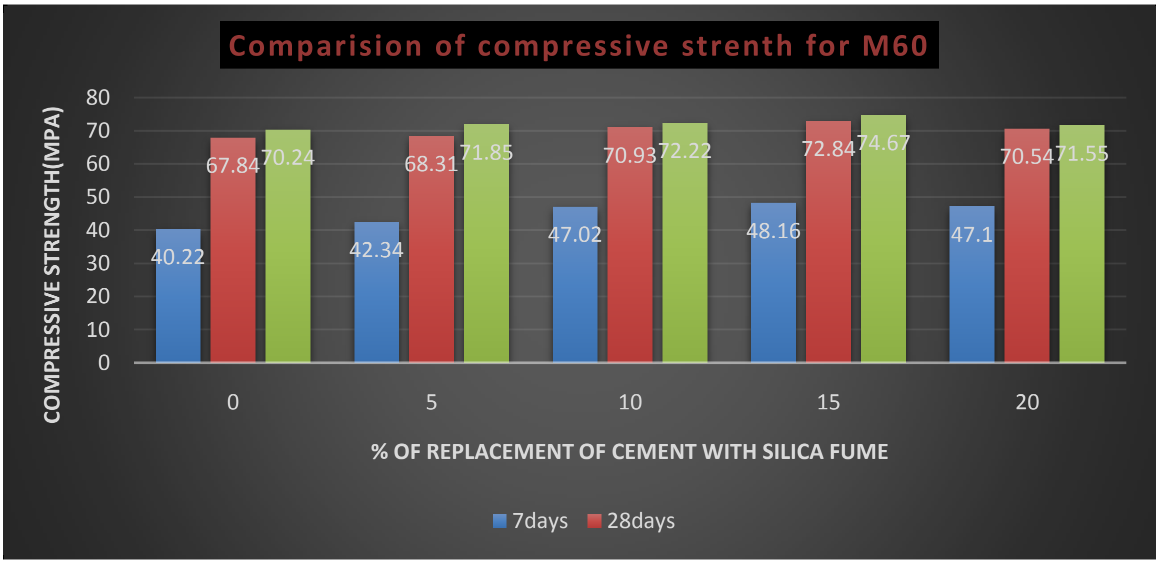
S.NO	Total Replacement By silica fume (%)(Mix)	Compressive strength (Mpa)
1	0	70.24
2	5	71.85
3	10	72.22
4	15	74.67
5	20	71.55



Plot 6.3. 56 Days Compressive strength

Table 6.4 Compressive Strength Results for Replacement of Cement by Silica Fume

S.No	Total Replacement By silica fume Only(Mix)	7 days	28 days	56 days
1	0	40.22	67.84	70.24
2	5	42.34	68.31	71.85
3	10	47.02	70.93	72.22
4	15	48.16	72.84	74.67
5	20	47.1	70.54	71.55



Plot 6.4. Comparison of Compressive strengths for M60

ACCELERATED CURING TEST RESULTS

Table 6.5 Compressive Strength Results for Replacement of Cement by Silica Fume

S.No	Total Replacement By silica fume Only(Mix)	Compressive strength(Mpa)
1	0	68.8
2	5	71.1
3	10	77.26
4	15	78.14
5	20	75.24

VII. CONCLUSIONS

- As the silica fume content increases the compressive strength increases up to 15% [HPC4] and then decreases. Hence the optimum replacement is 15%.
- Silica fume is much cheaper than cement therefore it is very important from economical point of view.
- Silica fume is a material which may be a reason of air pollution this is a byproduct of some industries.
- Use of micro silica with concrete reduces the air pollution.
- Silica fume also decreases the voids in concrete.
- Addition of silica fume reduces capillary

Refrences

[1]. ACI, 234R-96, "guide for the use of silica fume in concrete," Reported by ACI, Committee, 234, pp.1-51, 1996.
[2]. Shetty M.S: "Concrete Technology Theory and Practice" 3rd Edition, S. Chand Company Limited, New Delhi -
[3]. 1991.
[4]. Neville (2000):"Properties of Concrete" 4th and final edition, Pearson Education Asia Pvt. Ltd., England.
[5]. KrishnamRaju: "Design of Concrete Mix" 4th Edition C.B.S.Publishers and Distributors.
[6]. IS 7869 (Part-II):"Indian Standard Specification for Admixtures for Concrete – 1981.
[7]. AASHTO, Guide Specification on Alkali-Silica Reaction of silica fume.
[8]. Me land: "In the presence of lignosulfonate, the hydration reaction was retarded and less heat was evolved from paste containing silica fume".
[9]. Uchikawa (2012): "The use of excessive super plasticizer may cause substantial delays in setting times of cement paste containing silica fume".
[10]. Langan et al. (2010):"The effects of silica fume on the heat of hydration of Portland cement".
[11]. Lohtia and Joshi (2007): "Partial replacement of cement by silica fume results in reduction of heat of hydration without any reduction in strength".
[12]. Jaeger et al. (2004): "The alkali-silica reactivity of large silica fume derived particles".
[13]. Shanna (2000): "Designed and studied very high compressive strength of 69 to 110MPa along with incorporation of locally available natural pozzolana and silica fume".
[14]. Brooks et.al.(2000): "The effect of silica fume, Metakaolin, fly ash and ground granulated blast furnace slag on setting times of high strength concrete".
[15]. Alhozaimy, A.M., et al (1995): "Experimental investigations on the effects of adding low volume fractions (<0.3%) of calculated fibrillated polypropylene fibers in concrete on compressive flexural and impact strength with different binder compositions".

K. Amulya. " An Experimental study on strength properties of Hyper Concrete" IOSR Journal of Computer Engineering (IOSR-JCE) 21.4 (2019): 52-63.