A STUDY ON THE COMPRESSIVE STRENGTH OF CONCRETE BY USING SILICA FUME AS A PARTIAL REPLACEMENT OF CEMENT

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A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering



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Section – 24(B+D)

Semester: Spring – 2025

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Dedicated

To

"Our Beloved Parents"

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ABSTRACT

Generally, Portland composite cement is most commonly used making concrete in construction work. A by- product silica fume is partially replaced with concrete to improve the durability, strength and mechanical properties of the concrete. A by-product silica fume are increased the strength and durability of the concrete. Silica fume is added to increase the self- consolidating strength and compressive strength of the concrete. In this present an experimental work which carried out by silica fume as an additional material for cement and determine cement for M20 grade of concrete. We added silica fume in the concrete to replace 0% 10% 20% 30% 40% 50% weight of cement at increase of 10% for cylinder mold and find out the compressive strength after 7 and 28 days. For 7 days the average compressive strength of the concrete to reach 12.00 Mpa. The highest compressive strength of the concrete found 12.00 Mpa. For 28 days the average compressive strength of the concrete to reach 19.84 Mpa. The highest compressive strength of the concrete found 19.84 Mpa.

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CHAPTER 1
INTRODUCTION

1.1 General

In the construction work, concrete is widely used as a construction material which made in any shape and figure. The mechanical properties, durability and strength of the concrete able to be modifiable during making suitable exchange in its ingredient such as cement, aggregate and water by adding silica fume. They are improving the durability and strength in the concrete. Silica fume provide high strength to concrete. Silica fume is used to replace 0% to 50% of cement by weight at increment of 10% for cylinder mold.

Silica Fume

Silica fume is also known as micro silica; (CAS number 69012-64-2and EINECS number 273-761-1) is an amorphous (non-crystalline) polymorph of silicon dioxide, silica. It is an ultrafine powder collected as a by- product of the silicon. The main field of application is as pozzolanic material for high performance concrete. It is sometimes confused with fumed silica (also known as pyrogenic silica, CAS number 112945-52-5).

Chemical Composition of Silica Fume

Chemical composition of silica fume will mostly depend upon composition of the principle product being made by furnace. Additionally, the composition is also influenced by the furnace design; generally a furnace with a heat recovery system produces silica fume with lower ignition loss the SiO2 content of silica fume varies with the silica content of alloy being producer unlike other by product pozzolans such as fly ash, silica fume from a single source is little or no variation in chemical composition from one day to another.

History of Silica Fume

The first testing of silica fume in Portland- cement -based concrete was carried out in 1952. The Biggest drawback to exploring the properties of silica fume was a lack of material with which to experiment. Early research used an expensive additive called fumed silica, an amorphous form of silica made by combustion of silicon tetrachloride in a hydrogen-oxygen flame. Silica fume on the other hand, is a very fine pozzolanic, amorphous material, a by-

product of the production of elemental silicon or ferrosilicon alloys in electric arc furnaces. Before the late 1960s in Europe and the mid-1970s in the United States, silica fumes were simply vented into the atmosphere.

Production of Silica Fume.

Silica fume is a by-product in the carbothermic reduction of high purity quartz with carbonaceous materials like coal, coke, wood-chips, in electric arc furnaces in the production of silicon and ferrosilicon alloys.

Properties of Silica Fume.

The diameter of the silica fume particle ranges from 0.1 micron to 0.2 micron. The surface area about 30000 m2/kg. Density varies from 150 to 700 kg/m3 but when it is about 550 kg/m3, it is best suited as a concrete additive.

1.2 Background and Motivations

Background Concrete is the most widely used construction material in the world due to its versatility, durability, and relatively low cost. However, traditional concrete often requires improvement in its mechanical properties and durability to meet the increasing demands of modern infrastructure. One way to enhance the performance of concrete is through the use of supplementary cementitious materials (SCMs), such as silica fume. Silica fume, also known as microsilica, is a byproduct of the production of silicon and ferrosilicon alloys. It is an ultrafine powder with a high content of amorphous silicon dioxide (SiO_2). When added to concrete, silica fume reacts pozzolanically with calcium hydroxide (CH) released during cement hydration to form additional calcium silicate hydrate (C-S-H), which is the primary binder in concrete. This reaction refines the pore structure, reduces permeability, and enhances strength and durability.

The motivation behind using silica fume in concrete lies in its ability to significantly improve mechanical properties such as compressive, tensile, and flexural strength. Key reasons for studying the effect of silica fume on concrete strength include: Improved Compressive Strength, Increased Durability, Sustainable Construction, High-Performance Concrete.

1.3 Research Objectives of the Study

1. To determine the compressive strength of concrete by using silica fume as a partial replacement of cement.
2. To improve the properties of concrete by using silica fume.
3. To increase a high compressive strength of concrete.
4. To find the optimum percentage of silica fume in cement.

CHAPTER 2
LITERATURE REVIEW

2.1 Concrete

Concrete is a composite construction material made from a mixture of cement, water and aggregates (such as sand, stone, or crushed stone). When these ingredients are mixed together, they form a paste that hardens over time due to chemical reactions, primarily the hydration of the cement particles with water, resulting in a solid, durable material used in construction. Concrete in construction is structural material consisting of a hard, chemically inert particulate substance, known as aggregate usually sand and gravel, that is bonded together by cement and water. Concrete having a 28-days compressive strength of at least 21 MPa (3000 PSI) is normally considered high strength.

Many studies have been conducted to investigate the effect of Silica Fume in high strength concrete.

Amarkhail, N. (2015) investigated effects of silica fume on properties of high-strength concrete, Silica fume is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production. A certain percentage of silica fume as a cement replacement, can improve some properties of high-strength concrete such as compressive strength, flexural strength durability etc. The main objective of the study was to determine the optimum percentage of silica fume to replace cement in order to improve the properties of hardened high-strength concrete.

Vaitkus, A. et al.(2020) study effect of silica fume on high-strength concrete performance, the objective of this research is to comprehensively determine the effect of silica fume on high-strength concrete, which could be used for road pavement construction, performance. Three, the same type, concrete mixtures with different amount of silica fume (0%, 7% and 10%), but the same water/cement ratio (0.4) were produced and tested in compression, tension, bending and cyclic loading.

Selvapriya,R. (2019) silica fume as partial replacement of cement in concrete, In the recent past, there have been considerable attempts for improving the properties of concrete with respect to strength and durability, especially in aggressive environments. High performance concrete appears to be better choice for a strong and durable structure. A large amount of by-product or wastes such as fly-ash, copper slag, silica fume etc. Are generated by industries, which causes environmental as well as health problems due to dumping and disposal. Proper introduction of silica fume in concrete improves both the mechanical and durability characteristics of the concrete

Sabale,V. (2014) studied the effect of addition of silica fume on properties of high strength concrete, The use of high strength concrete in major constructions has become obligatory, whose mechanical properties are still at a research phase. In the paper the attempt has been made to study the properties of high strength concrete by adding silica fume in different percentage to the weight of cement. The properties include 7 days and 28 days compressive strength, splitting tensile strength and flexural strength of concrete.

Preetha, V. (2019) investigate on effect of silica fume on workability and strength of concrete, the principle physical effect of silica fume in concrete is that of filler, because of its fineness can fit into space between cement grains in the same way that sand fills between particles of coarse aggregates and cement grains fill the space between sand grains. As for chemical reaction of silica fume, because of high surface area and high content of amorphous silica in silica fume, this highly active pozzolans reacts more quickly than ordinary pozzolans. The use of silica fume in concrete has engineering potential and economic advantage. This paper presents the optimal percentage of silica fume from the results of an experimental investigations carried out to for sustainable and economical production of concrete

Amudhavalli and Mathew (2012) studied the effect of silica fume on the strength and durability characteristics of concrete. The main parameter investigated in this study is M35 grade concrete with partial replacement of cement by silica fume by 0%, 5%, 10%,15% and by 20%. a detailed experimental study in Compressive strength, split tensile strength, flexural strength at age of 7 and28 day was carried out. Results Shows that Silica fume in concrete has improved the performance of concrete in strength as well as in durability aspect.

2.2 Cement

Cement is a fine powder made from a mixture of mineral substances that, when mixed with water, forms a paste that hardens over time. It is one of the key ingredients in concrete, along with aggregates (sand, gravel, or crushed stone) and water. Cement acts as a binding agent, holding together the other components of concrete and providing strength to the material once it sets and cures. For making structural concrete, so called hydraulic cements are used exclusively. Water is needed for the chemical process (hydration) in which the cement powder sets and hardens into solid mass.



Figure 2.1: Cement

2.3 Portland Composite Cement

Portland Composite Cement (PCC) is a type of cement that combines Portland cement with a range of additional materials (also called blended materials or supplementary cementitious materials). These materials are added to improve certain properties of the cement, such as its durability, strength, and workability, while also making it more sustainable by reducing the carbon footprint associated with cement production. Portland Composite Cement is a more sustainable and durable alternative to traditional Portland cement, incorporating supplementary materials that enhance performance and reduce environmental impact. It is widely used in a variety of construction projects due to its improved properties, cost-effectiveness, and lower carbon footprint.

2.4 Water Cement Ratio

The water cement ratio is the ratio of the weight of water to the weight of cement used in a concrete mix. A lower ratio leads to higher strength and durability but may make the mix difficult to work with and form. Workability can be resolved with the use of plasticizers or super plasticizers. Water cement ratio produced by conventional mixing technologies are usually prepared with water cement ratio in the range of 0.45 for grade M20, and their 28 days' compressive strength is about 60 to 10 MPa when normal density aggregate is used to (FIP/CEB. 1990). The requirements for water quality stringent than those for conventional concrete. Usually, water for concrete is specified to be a portable quality.

2.5 Aggregates

Aggregates are used in a variety of industries for a range of purposes Aggregates are classified by particle size and consistency. They can be subdivided into the categories natural stone aggregates (sand and gravel) and crushed aggregates (stone chippings and crushed stones). Aggregates are generally available in the form of a homogeneous bulk product. The product characteristics are standard, in order to ensure the necessary levels of reliability and processes ability. They are a primary component in the production of concrete and asphalt, but also serve as a filter and fill material or as a basic material for road building and railway construction. Our product portfolio varies from country to country

2.5.1 Coarse Aggregate

Coarse aggregates refer to irregular and granular materials such as sand, gravel or crushed stone and are used for making concrete In most cases, coarse is naturally occurring and can be obtained by blasting quarries or crushing them by hand or crushers. It is imperative to wash them before using them for producing concrete. Their angularity and strength affect the concrete in numerous ways. Needless to say, the selection of these aggregates is a very important process. The size of coarse aggregates affects several aspects of the concrete, mainly strength and workability and the amount of water needed for the concrete mix.



Figure 2.2: Coarse Aggregate

2.5.2 Fine Aggregates

Aggregate is the granular material used to produce concrete or mortar and when the particles of the granular material are so fine that they pass through a 4.75 mm sieve, it is called fine aggregate. It is widely used in the construction industry to increase the volume of concrete; thus, it is a cost saving material and you should know everything about the fine aggregate size, its density and grading zone to find the best material Fine aggregate is the essential ingredient in concrete that consists of natural sand or crushed stone.



Figure 2.3: Fine Aggregate

2.5.3 Silica Fume

Silica fume is also known as micro silica; (CAS number 69012-64-2and EINECS number 273-761-1) is an amorphous (non-crystalline) polymorph of silicon dioxide, silica. It is an ultrafine powder collected as a by- product of the silicon. The main field of application is as

pozzolanic material for high performance concrete. It is sometimes confused with fumed silica (also known as pyrogenic silica, CAS number 112945-52-5).

2.6 Sieve Analysis of Fine and Coarse Aggregates.

The analysis is conducted to determine the grading of material proposed for use as aggregates. The term "sieve analysis" is the sample operation of dividing a sample of aggregates into fractions each consisting of particles between specific limits. The term Fineness Modulus (F.M) is a ready index of coarseness or fineness of material. It is an empirical factor obtained by adding the cumulative percentages of aggregates retained on each of the standard sieves and dividing this sum arbitrarily by1000.

No. 100, No. 50, No. 30, No. 16, No. 8, No. 4, and 3/8 in. are the ASTM standard sieves. This test method conforms to the ASTM standard requirements of specification C136.

2.7 Compressive Strength Importance

a) Effect of cement

The Inhaling light levels of dust may occur when workers empty bags of cement. In the short term, such exposure irritates the nose and throat and causes choking and difficult breathing. Cement industry is one of the main producers of carbon dioxide, a potent greenhouse gas. Concrete causes damage to the most fertile layer of the earth topsoil Compressive strength increases with the increasing of cement content. Cement dust may enter into the systemic circulation and thereby reach the essentially all the organs of body and affects the different tissues including heart, liver, spleen, bone, muscles and hairs and ultimately affecting their micro-structure and physiological performance

b) Effect of aggregate/cement ratio

Well graded aggregates result in the least number of voids in a given volume. Less voids result in excessive paste availability in a unit volume and more lubrication decreasing the aggregate/cement ratio increases the compacting factor due to the increase in the number of fines (cement) in the mix and decreasing aggregate content, which acts as lubricant and leads to a decrease in the internal friction between the aggregates particles, and as a result, compacting factor increases

c) Effect of aggregate properties

Aggregates influence the properties of concrete/mortar such as water requirement, cohesiveness and workability of the concrete in plastic stage, while they influence strength, density, durability, and permeability, surface finish and color in hardened stage. Aggregate is commonly considered inert filler, which accounts for 60 to 80 percent of the volume and 70 to 85 percent of the weight of concrete. Although aggregate is considered inert filler, it is a necessary component that defines the concrete's thermal and elastic properties and dimensional stability.

d) Effect of admixture

Admixtures have increased both compressive strength and durability of concrete.

e) Effect of the specimen size

Concrete strength decreased as the specimen size increased and the decrement was more obvious in the specimens with low aspect ratio.

f) Effect of the rate of loading

As a rate of loading increases, compressive strength, modulus of elasticity, and the slope of the descending portion of the stress-strain curve of concrete increase.

g) Effect of the moisture content

The results indicate that, with increasing moisture content, the compressive strength Decreases initially and then increases. The effect of moisture content on compressive strength increases with the increasing porosity.

h) Effect of the temperature of the testing

The compressive strength can be classified into four distinct patterns of strength loss: 23-200°C, 200-400°C, 400-600°C, and 600-800°C. From 23 to 200°C, the compressive strength of specimens increases with temperature.

2.8 Compressive Strength Formula

Compressive strength is the maximum compressive stress that, under a gradually applied given solid material can sustain without fracture. Compressive strength is calculated by dividing the maximum load by the original cross-sectional area of a specimen in a compressive test. The compressive strength is one of the most important and useful properties of concrete. The design strength of the concrete normally represents its 28^{th} days compressive strength can be defined as the capacity of concrete to withstand loads before failure of the many tests applied to the concrete, the compressive strength test is the most important, as it gives an idea about the characteristics of the concrete.

The compressive strength was calculated by using the equation F=P/A**.** Where, F is compressive strength of specimen in pound per square inch (psi). P is the maximum applied load by pound. A is the cross-sectional area (inch square). Compressive strength test, mechanical test measuring the maximum amount of compressive load a material can bear before fracturing.

CHAPTER 3
METHODOLOGY

3.1 Preparation of Cylinder

The Comprehensive strength of the concrete cylinder is one of the most common performance measurers performed by the engineers in the structural design. The comprehensive strength of concrete cylinders is determined by applying continuous load over the cylinder until failure occurs. The test is conducted using a compression testing machine. The cylinder specimens are cast in steel, cast iron or any mold made of non-absorbent material. Even under severe conditions, the molds used must retain its original shape and dimensions. Cylindrical specimens for testing should be 4inch x 8 inch. The mixed concrete is placed in to the molds in layers than 5 cm deep. The strokes per layer during the compaction must not be less than 25 in number Compaction must reach the underlying layers allowing the majority of the air voids to escape. The samples are taken and submerged in clean and fresh water until the testing age is reached.



Figure 3.1: Mold Preparation for Casting

3.2 Concrete Mixing

A concrete mixer is a device that homogeneously combines cement, aggregate such as sand or coarse aggregate, and water to from concrete. A typical concrete mixer uses a revolving drum to mix the components. This process is so crucial that if the concrete making ingredients aren't mixed properly, it can lead to concrete failure under compression load. A concrete mixture ratio of 1-part cement, 1.5 parts sands, and 3 parts aggregate will produce a concrete mix of approximately 3000 psi. Mixing water with the cement, sand and coarse aggregate will from a paste that will bind the materials together until the mix hardens. The primary goal of concrete mixing is to make the concrete mass homogeneous and uniform in color while maintaining the required consistency. Production of good quality and bad quality of concrete includes the same material, but the proportion and mixing methods can be differentiating. As a result, sufficient precautions should be followed while mixing concrete.



Figure 3.2: Mixing of Sand Cement and coarse aggregate

3.3 Casting of Cylinder

Casting is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process. Casting is most often used for making complex shapes that would be otherwise difficult or uneconomical to make by other methods. In addition to the exact geometry of the component, the possible casting and molding methods must also be taken into account in advance in order to obtain an optimum cast part under series production conditions too. Besides various changes to the construction, initial experiences with regard to future component properties, rejections and rework are also gained during pilot production. It is extremely important to have been rejection and ultimately all factor that restrict the output under control by the start of series production at the latest. This is the only way to achieve high productivity and low costs at the same time in order to be able to maintain the specified price for the component.



Figure 3.3: Casting of Cylinder

3.4 Curing

The curing of concrete is the process of keeping the concrete damp or moist and warm after the initial setting of concrete or removal of formwork. Proper curing of concrete maintains the satisfactory moisture content and favorable temperature inside the concrete so that

hydration of cement may continue until the desired properties are developed. The curing of concrete must be continued for a reasonable period of time to achieve its desired strength and durability. Initial curing during the first 24 to 48 hours after molding, all test specimens are stored. After curing, a large amount of water needs to be disposed of on the curing side. But water cooler than 50c is not suitable for curing concrete. As the hydration reaction in concrete expels heat and keeps concrete warm, using cold water less than 50c on concrete may lead to cracking and failing. Alternate drying and wetting on the concrete surface causes volumetric changes in concrete and ultimately leads to cracking.



Figure 3.4: Curing of Cylinder

3.5 Preparation to Crush the Concrete Cylinders

The cylinders were kept submerged as long as for 7 days. After that were withdraw 18-piece cylinder are made by different percentage of silica (10%, 20%, 30%, 40%, 50%), In Sonargaon University (SU) Lab, after that the cylinders had been placed in the center of Universal Testing Machine (UTM) one by one (take help from the manual) to find out the crushing of each cylinder. Then we kept another test for 28 days. After that we are withdrew from the dram and crushing the cylinders and noted down the value.



Figure 3.5 Measurement of cylinder



Figure 3.6 Measurement of cylinder Height

3.6 UTM Machine

UTM machine is also known as UTM tester, materials testing machine or material testing frame and that's why manufactures gave a common name "Universal testing machine" and this machine is used to test the compressive strength of materials. UTM machines have different roles stripped of capabilities or marketed for specific industries & sectors which play unique roles in the development of infrastructure, roads, and highways.



Figure 3.7: Place the cylinder in UTM machine

3.7 Compression Test

Compressive strength of materials is completely opposite of tensile strength testing as mentioned above, basically a maximum pressure has to apply on any object up to its break points. This is called compressive strength of any object. This test also useful to find how much load can bear on bridges pillars, building beams or etc.

3.8 Compressive Strength Test

Compressive strength test, mechanical test measuring the maximum amount of compressive load a material can bear before fracturing. The test piece, usually in the form of a cylinder is compressed between the platens of a compression testing machine by a gradually applied load. Brittle materials such as rock, brick, cast iron, and concrete may exhibit great compressive strengths but ultimately, they fracture. The crushing strength of concrete, determined by breaking a cylinder, and often called the cylinder strength. Some ductile metals, such as mild steel, have very great compressive strengths, but the actual values are difficult to measure. When a load is applied to a ductile metal, it deforms elastically up to a certain point and then plastic deformation occurs. Increasing loads may even completely flatten a test piece without any definite fracture occurring, so that value can be obtained for the compressive strength.

CHAPTER 4
RESULT AND DISCUSSION

4.1 Result of Fine Aggregate

The test sample of the aggregate (F.M) shall wet after drying, approximately the following.

Requirement:

Aggregate with at least 85% passing No. 4 Sieve 1000gm.

And more than 3.4% retained on a No. 8 Sieve.

Aggregates with at least 96.6% passing No. 8 Sieve 34gm.

Table 4.1 Result of Fine Aggregate

Sieve No.	Retain	% Retain	Cumulative % Retain	FM	Finer
#4 (4.75mm)	24	2.4	2.4	261.5/100 = 2.615	97.6
#8 (2.36mm)	59	5.9	8.3		91.7
#16 (1.19mm)	132	13.2	21.5		78.5
#30 (0.59mm)	224	22.4	43.9		56.1
#50 (0.30mm)	428	42.8	86.7		13.3
#100 (0.15mm)	120	12	98.7		1.3
Pan	13				

4.2 Result of Coarse Aggregate

The weight of the test sample of coarse aggregate (C.A) shall conform to the following requirements:

Table 4.2: Result of Coarse Aggregate

Sieve No.	Retain	% Retain	Cumulative % Retain	FM	Finer
#3/4	212	21.2	21.2	715.5/100 = 7	78.8
#3/8	713	73.1	94.3		5.7
#4	57	5.7	100		0
#8	0	0	100		0
#16	0	0	100		0
#30	0	0	100		0
#50	0	0	100		0
#100	0	0	100		0

Calculation:

1. Calculate percentages passing, total percentage retained, or percentages in various size fractions to the nearest 0.1gm on the basis of the total weight of the initial dry sample.

2. Calculate fineness modulus, when require, by adding the total percentage of material in the sample that is coarser than each of the flowing sieves (Cumulative percentage retained), and dividing the sum by 100. 150-tm (No. 100), 300pm (No. 50), 600-llm (No. 30), 1.18mm (No. 16), 2.23mm (No.8), 4075mm (3/8 in), 37.5mm (1.5 in) and larger, increasing in the ratio of 2 to 1.

4.3 Specific Gravity of Coarse Aggregate

Table 4.3: Data sheet for specific gravity of coarse aggregate

Wt. of pycnometer Filled with water to Calibration, B gm	Oven Dry Wt. in air. A gm	Wt. of pycnometer with Specimen and water to Calibration mark, C gm
1952 gm	2000 gm	1295 gm

Table 4.4: Specific gravity of coarse aggregate

Test	Formula	Calculation	Result
Apparent Specific Gravity	A/(A-C)	1952/(1952-1295)	2.98
Bulk Specific Gravity (S.S.D. Basic),	B/(B-C)	2000/(2000-1295)	2.83
Bulk Specific Gravity (Oven Dry Basic)	A/(B-C)	1952/(2000-1295)	2.76
Absorption Capacity. D%	(B-A) x 100)/A	(2000-1952) x100)/292	2.45

Table 4.5: Specific gravity of fine aggregate

Test	Formula	Calculation	Result
Apparent Specific Gravity	A/(B+A-C)	292/(656+242-838)	2.65
Bulk Specific Gravity (Oven Dry Basic)	A/(B+S-C)	292/(656+300-838)	2.48
Absorption Capacity. D%	(S-Ax100)/A	(300-292x100)/292	2.73
Bulk Specific Gravity (S.S.D. Basic), G	S/(B+S-C)	300/(656+300-838)	2.54

The specific gravity of the Sylhet sand as fine aggregate after oven drying was found 2.48. Specific gravity for fine aggregate We found the specific gravity of the apparatus to be 2.65. and bulk specific gravity oven dry ac obtained from 2.48. Apparent capacity redaction received 1.754 And bulk SSD received 2.58.

4.4 7 Days Compressive Strength Test

Table 4.6: 7 Days Compressive Strength Test

Cylinder Number	Course Aggregate	Fine Aggregate	Silica %	Mix Properties	Water cement ratio	Compressive strength (PSI)	Average strength (PSI)	Average strength (MPa)
1	Indian pakur Stone	Sylhet Sand	0%	1:1.5:3	0.45	1579.39 1651.59 1456.54	1562.50	10.77
2			10%	1:1.5:3	0.45	1763.13 1798.40 1656.60	1739.37	12.00
3			20%	1:1.5:3	0.45	1389.41 1505.75 1417.17	1437.44	9.91
4			30%	1:1.5:3	0.45	844.17 1127.57 979.71	983.81	6.79
5			40%	1:1.5:3	0.45	881.56 969.72 779.44	876.90	6.04
6			50%	1:1.5:3	0.45	536.94 539.52 561.56	546.00	3.77

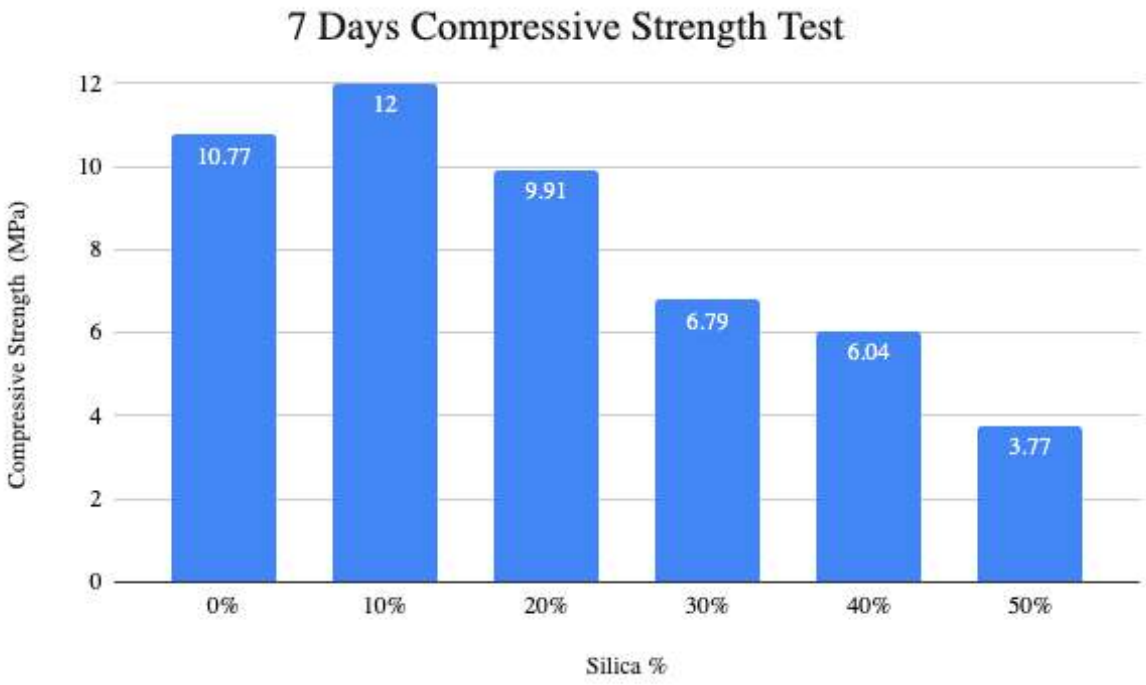


Figure 4.1: 7 Days Compressive Strength Test

4.5 28 Days Compressive Strength Test

Table 4.7: 28 days Compressive Strength Test

Cylinder Number	Course Aggregate	Fine Aggregate	Silica %	Mix Properties	Water cement ratio	Compressive strength (Psi)	Average strength (Psi)	Average strength (MPa)
1	Indian pakur Stone	Sylhet Sand	0%	1:1.5:3	0.45	2640.61 2614.76 2732.86	2662.74	18.36
2			10%	1:1.5:3	0.45	2851.03 2901.20 2879.81	2877.34	19.84
3			20%	1:1.5:3	0.45	2452.03 2415.5 2582.88	2483.47	17.12
4			30%	1:1.5:3	0.45	2058.28 2114.27 2037.19	2069.92	14.27
5			40%	1:1.5:3	0.45	1770.93 1762.45 1879.30	1804.22	12.44
6			50%	1:1.5:3	0.45	1410.5 1308.45 1146.03	1288.32	8.88

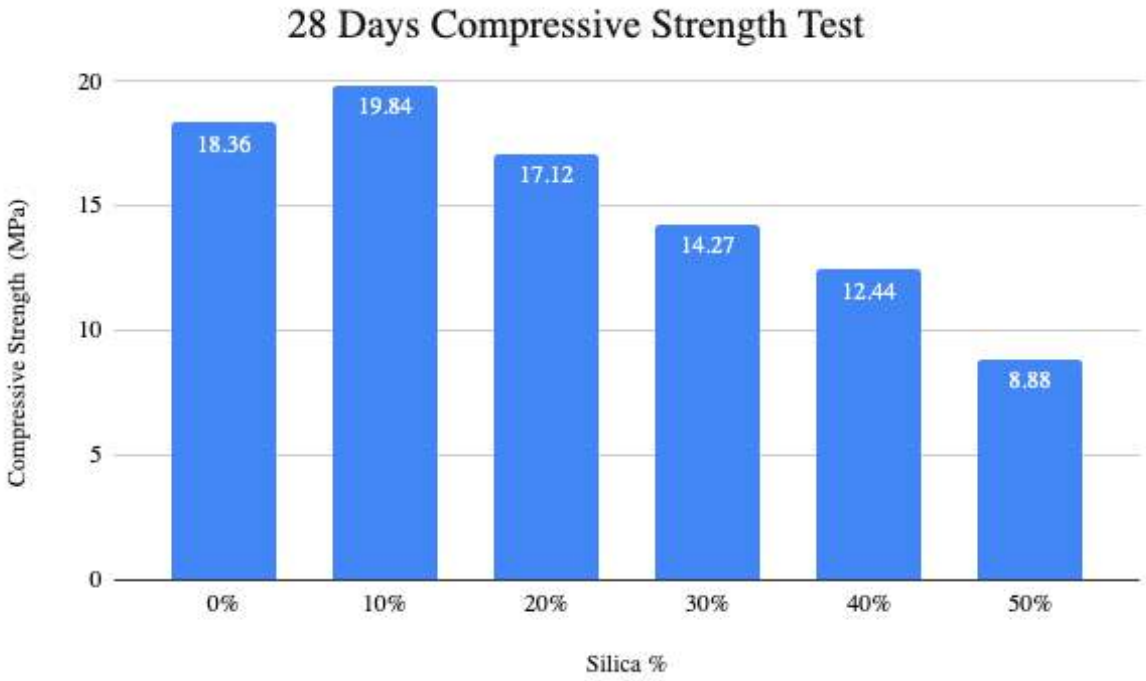


Figure 4.2: 28 Days Compressive Strength Test

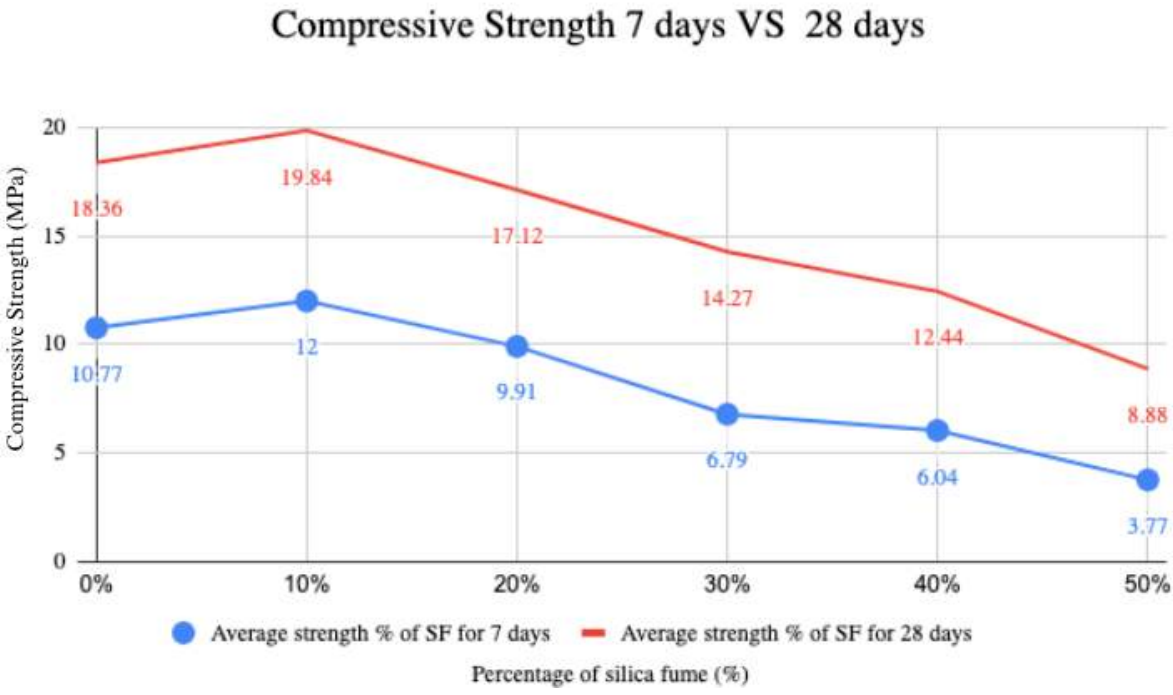


Figure 4.3: Compressive Strength (MPa) 7 days vs 28 days (Silica)

After the experiment shows below the result for grade M20 compressive strength: -

- For without silica fume, Compressive strength of the concrete is to reach 18.30 Mpa in 7 day & 23.55Mpa in 28 days.
- For 10% silica fume, Compressive strength of the concrete is to reach 12 Mpa in 7 days & 19.84 Mpa in 28 days
- For 20% silica fume, Compressive strength of the concrete is to reach 9.91 Mpa in 7 days & 17.12 Mpa in 28 days.
- For 30% silica fume, Compressive strength of the concrete is to reach 6.79 Mpa in 7 days & 14.27 Mpa in 28 days.
- For 40% silica fume, Compressive strength of the concrete is to reach 6.04 Mpa in 7 days & 12.44 Mpa in 28 days.
- For 50% silica fume, Compressive strength of the concrete is to reach 3.77 Mpa in 7 days & 8.88 Mpa in 28 days.

For 7 days the average compressive strength of the concrete to reach 9.47 Mpa. the highest compressive strength of the concrete found 18.30 Mpa for without silica fume and the lowest compressive strength is 3.77 MPa for 50% silica fume.

For 28 days the average compressive strength of the concrete to reach 16.02 Mpa. the highest compressive strength of the concrete found 23.55 Mpa for without silica fume and the lowest compressive strength is 8.88 Mpa for 50% silica fume.

The compressive strength without silica fume is better for high strength concrete.

CHAPTER 5

CONCLUSION AND FUTURE WORKS

5.1 Decision

The main findings of the study are mentioned below –

1. In this study, an experimental study has been conducted on concrete by varying the percentage of silica fume as 10%, 20%, 30%, 40%, 50% respectively to study the increase in the compressive strength of concrete.

2. The fume of silica reduces bleeding greatly since the wetting of the large silica fume layer absorbs free water and therefore also decreases the amount of free water remaining in the bleeding mix. Silica fume also blocks the pores of the fresh cement to prevent the water from entering the surface within the concrete.

3. The compressive strength of concrete by adding 10% silica fume is 12 MPa and 19.84 MPa for 7 and 28 days respectively. By adding 10% silica, the compressive strength tends to increase with increase percentages of silica fume in the mix and decreases after 10% replacement. The optimum strength of cube is gain at 10% replacement for all 7 and 28 days.

4. The optimum percentage of silica fume is found to be 10% whereas beyond that the strength is reduced. The addition of silica fume more than 10% reduces the workability of concrete.

5.2 Recommendation

1. Different w/c ratio may be considered within a reasonable range can be investigated.

2. Concrete with different mixture proportions can be studied.

3. Avoid high silica fume replacements (20%–50%) as they severely reduce strength.

4. Evaluate other properties: Silica fume improves durability, permeability, and chemical resistance, if these are critical, a trade-off in strength may be acceptable.

5. Test longer curing periods: Silica fume concrete sometimes gains strength beyond 28 days; check 56/90-day strengths if applicable.

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