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Effect of Silica Fume on Mechanical Properties Of Concrete: a review

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Abstract- Silica fume is an industrial outgrowth of producing silicon metal or ferrosilicon alloys. ...Concrete accommodate. silica fume can have very tough and can be very long lasting. Silica Fume is usedto improved the mechanical properties of concrete .it is too fine product that easily mix with cement. it isavailable in too fine powdered form having its size is less than 1 micron as a diameter of 0.1 micron. We will replace cement by Silica fume with 3%,6%,9%,12%,15% respectively. Total 105 standard size cube where to be cast within 1:1.5:3 (M20). Equal number of cubes were cured for 3 ,7,28,56,90 days. In this project we will do compressive strength, flexural strength, split tensile strength. Chemical composition test are XRD (X-ray diffraction),XRF(X-ray fluoresce) spectrometer analysis, SEM(Scanning electron microscope) were carried.

Keyword- Cement, concrete, sustainability, silica fume, slump test.

Introduction

Silica fume is a micro-sized particle made mostly from ferrosilicon and silicon metal and used as a secondary cementing ingredient. It interacts swiftly with the calcium hydroxide formed during the hydration of Portland cement. The addition of silica fume purifies the pore structure and improves the mechanical strength of the concrete. Silica fume has an excessively high specific surface area, causing it to operate as a reactive pozzolan. In comparison to other pozzolanic compounds, silica fume is typically utilized in smaller volumes. It is difficult to scatter it in concrete since it is homogeneous. From a technical standpoint, silica fume is a very promising mineral admixture, especially for producing high- to ultra-high-strength concrete, but caution must be exercised during the mixing process. The benefits of utilizing silica fume in concrete as a partial substitute for cement were investigated in this study. Cement can be discovered. The purpose of this study was to compare the mechanical properties of regular concrete versus concrete made with silica fume. By replacing cement with silica fume at various percentages and comparing the strength metrics to normal concrete, a suitable percentage of silica fume was discovered.
The benefits of utilizing silica fume in concrete as a partial replacement for cement are discovered in this study. The purpose of this study was to compare the mechanical properties of regular concrete versus concrete made with silica fume. By replacing cement with silica fume at various percentages and comparing the strength metrics to normal concrete, a suitable percentage of silica fume was discovered.

OBJECTIVE

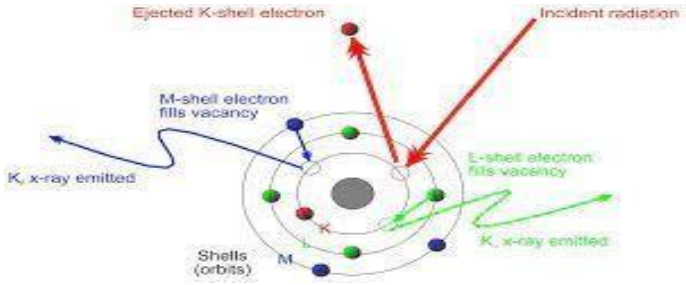
Our goal is to research silica fume and learn about its properties as well as its impact on concrete in various quantities. In this study, we are employing silica fume to test chemically inert plastic surface (PET) fibers, which will then be used to improve the qualities of concrete. As a result, we are researching silica fume before using it. It had already been subjected to some scrutiny. In this issue, we need to put in more effort to increase the concrete properties to a very high level.

Test Perform on Material

XRF Analysis

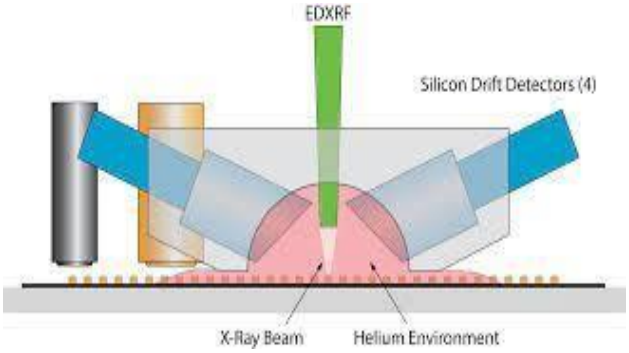
The non-destructive analytical technique XRF (X-ray fluorescence) is used to determine the elemental makeup of materials. By detecting the fluorescence (or secondary) X-ray released by a sample when it is excited by a main X-ray source, XRF analyzers may determine the chemistry of a sample. X-ray fluorescence analysis can be study of as spectrochemical analysis

within an X-ray region. It has the same attribute as atomic soaking up spectrometry and optical emission spectrometry except that the sample does not need to be melt in a solution to be a examine. Flameless atomic attribute spectrometry (FLAAS) atomizes the elements in a sample in a 2000 to 3000C flame. ICP optical emission spectrometry (ICP-OES), animate a sample in a 6000 to 9000C plasma flame. X-ray fluorescence likewise animate the sample to acquired information from X-rays.



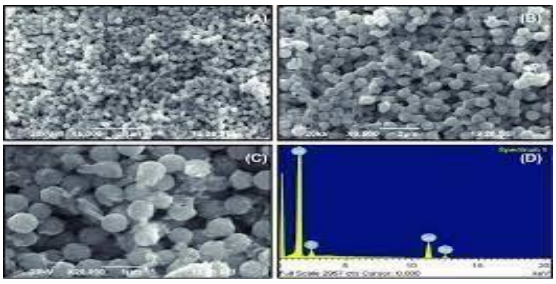
XRD Analysis

The nondestructive technique of X-ray diffraction (XRD) offers extensive information about the crystallographic structure, chemical composition, and physical properties of materials. The technique is often known as x-ray talc diffraction because the material being analyzed typically is a ultimately ground down to a uniform state. Emission is when light bends slightly as it passes around the edge of an object encounters an obstacle or aperture.
The degree to which it occurs depends on the relative size of a wavelength compared to the dimensions of the barrier or open it encounters



SEM Analysis

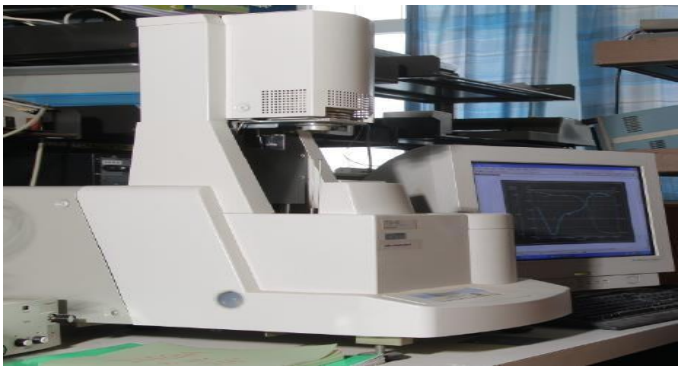
The electronic console and the electron column are the two major components of the SEM instrument. Instrument modifications such as filament current, accelerating voltage, focus, magnification, brightness, and contrast can all be made using the electronic console's control knobs and switches. The FEI Quanta 200 is a cutting-edge electron microscope that use a computer system in conjunction with an electronic console, eliminating the need for a bulky console that holds control knobs, CRTs, and an image capturing device. The mouse and keyboard are used to access all of the primary controls through the computer system. The user just needs to be familiar with the graphical user interface (GUI) or software that controls the instrument, rather than the control knobs and switches present on earlier instruments.



TGA/DTA

TGA (Thermogravimetric Analysis): determines decomposition/mass loss over a temperature range. DTA (Differential Thermal Analysis): determines endo- and exothermic event temperatures, and shows phase transitions.
Material And Methodology

TGA, DTA, and DSC are three terms used to describe the analysis of compounds that take part in chemical reactions using changes in temperature of these compounds. TGA stands for Thermal Gravimetric Analysis, and DTA stands for Differential Thermal Analysis while DSC stands for Differential Scanning Calorimetry
In practice thermal analysis gives properties like; enthalpy, thermal capacity, mass changes and the coefficient of heat expansion. Solid state chemistry uses thermal analysis for studying reactions in the solid state, thermal degradation reactions, phase transitions and phase diagrams.



Material Is Used For Project

Silica Fume
The Silica Fume is in an Ultrafine powdered form having size less than 1 micron and with an average diameter of about 0.1 microns.
Silica fume is an industrial by-product used in concrete mixes to replace cement. Surface area of silica fume is $20m^2/kg$. The diameter of silica fume particle is about 0.1-0.2Ïm.

Cement

Cement is a dry powder made from the calcination of lime and clay. In this study, ordinary Portland cement of grade 43 according to IS 4031-1988 was used. The following table summarizes the many qualities of cement: A cement is a binder, a substance used for construction that sets, hardens, and stick to other materials to bind them together. Cement is hardly used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate generate mortar for masonry, or with sand and gravel, generate concrete. Concrete is the most widely used material in existing and is behind only water as the planet's most-consumed resource.

Table1. Properties of Cement

Sr.No.	Property	Result
1	Normal consistency	33 %
2	Initial setting time	42 min
3	Specific gravity	9.99
4	Fineness of cement	5 %
5	Specific area	3250cm^2/gm
6	Soundness of cement	1.00 mm

Fine Aggregate

Fine aggregate is a naturally occurring granular material composed of finely divided rock and mineral particles.
M sand was used as fine aggregate of grading zone II. The properties of fine aggregate are shown in table below:

Table 2. Properties of Fine Aggregate

Sr. No	Property	Result
1.	Bulk Density	1625 kg/m^3
2.	Fineness modulus	3.80
3.	Specific gravity	2.67
4.	Water absorption	1.2

Coarse Aggregate

Crushed granite obtained From machine crusher is used as Coarse aggregate.
Coarse aggregate of size 20 mm of crushed stone locally available confirming to IS 383-1987 was used.

Table 3. Properties of Coarse Aggregate

Sr. No	Property	Result
1.	Bulk Density	1525 kg/m^3
2.	Fineness modulus	3.67
3.	Specific gravity	2.89
4.	Water absorption	0.46

Water

Water is an essential component when making concrete. The moisture that water provide also gives concrete its strength during the curing process while water is one of the most ingredient of concrete.

Mixing:

Mixing as per mix design M20 grade concrete. the silica fume is added to the conventional concrete by the different percentages of 0%, 3%, 6%, 9%, 12%, and 15% by weight. The maximum compressive strength rises from 2% to 6% after that it begins to decline this can be represented by the graph. From graph the 0ptimum value is taken as 12% which gives higher compressive strength properties to cement mortar.

Casting:

To perform investigation in the above context the research proceeds with casting of 105 cubes of size 150mm*150mm*150mm, cylinders of size 150mm diameter and 300mm height, and size 700mm*150mm*150mm. These specimens are undergone under various tests such as compressive strength, flexural and split tensile strength.

Curing:

After completion of casting the curing is required for specimens. The curing duration may be varied for different type of specimens. For the cubes and cylindrical specimens are cured by ages of 3 days,14 days and 28 days and beams were cured 28days curing period.

Mechanical Testing

Slump cone test :-

The effect of silica fume addition to the concrete as cement replacement on workability characteristic is shown in Given Fig graphically. As the percentage of silica fume increases from 0% to 25% the slump decreases from 100 to 71mm. The reduction in slump is attributed to the particles size, surface area and size of silica fume particle which is very much lesser than cement particles and it requires more water than cement for a given slump. Figure 1 shows the slump test performed for the fresh concrete.

Compressive Strength test :-

To determine the precise compressive strength of cubes an average of two samples were taken for every reading. The testing of specimens has been performed after curing period of 3 days,7 days days, 28 days and for both controlled as well as for cubes with partial replacement of cement with fine aggregates with the addition of silica fume. The test was carried out conforming to IS 516-1959

Split Tensile Strength Test :-

The main purpose of calculating split tensile strength is to figure out how concrete behaves under tension. Because it is impossible to deliver a really axial force in direct tension, it is difficult to test tensile strength directly. That's why it's done in a roundabout way.

The test was carried out conforming to IS 516-1959 to obtain Split Tensile Strength of Concrete strength at the age of 3 days ,7 days and 28 days.

Flexural Strength Test:

To determine the precise flexural strength an average of three samples were taken for every reading. The specimen size was fixed at 150*150*700 mm. The testing of specimens has been performed after curing period of 3 days , 7 days and 28 days for both controlled as well as for beams with partial replacement of cement with fine aggregates with the addition of silica fume The test was carried out conforming to IS 516-1959.

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Conclusion

Compressive strength is increased when 0% to 15% of cement is replaced with silica fume, however compressive strength is decreased when 15% to 20% of cement is replaced with silica fume. The ideal percentage of silica fume is found to be 15%, after which the strength begins to deteriorate. Workability is harmed when silica fume is added. A high fineness concentration in silica fume leads to a high level of normal consistency. The strength improvement in compressive strength due to silica fume replacement is virtually identical to the strength gain in split tensile strength. Concrete cavities are also reduced by silica fumes. The addition of silica fume to concrete improves bond strength. Silica fume concrete has a similar modulus of elasticity to normal concrete.

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