An Experimental Investigation To Determine The Cement Concrete Strength With Silica Fume And Cenosphere

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Abstract- *Concrete is one of the important materials of the construction industries. Now a days due to increase in a population, the demand of infrastructure is increasing day by day. This leads to increase in production of cement. In the present time the world wide cement production is about 1.6 billion tons. This huge amount of production leads to consumption of natural resources and it is also harmful for environment. The main components of the gases emitted from cement industries are CO_2, N_2, O_2, SO_2, water vapors and micro components i.e. CO and NOx. Large quantity of waste by products are produced from the manufacturing industries such as mineral slag, fly ash, silica fumes etc. Cenosphere is a lightweight, hollow sphere made largely of silica and alumina and filled with air, metals, or gas. The Cenosphere was produced as a byproduct of coal combustion at thermal power plants. On the other hand silica fume industrial by product found to be an attractive cementations material which is by product of smelting process in the silicon and ferrosilicon industry. The aim of this study is to evaluate the performance of Silica Fume and Cenosphere an industrial by product as a admixture in concrete. The main parameter investigated in this study M-30 concrete mix with partial replacement by silica fume with varying 0, 10, 20, 30 and 40% by weight of cement and Cenosphere with 0, 2, 4 and 6% by weight. The paper presents a detailed experimental study on compressive strength, flexural strength and split tensile strength for 7 days, 14 days and 28 days respectively.*

Keywords- Cenosphere, Silica fume, workability, compressive strength, split tensile strength test, flexural stregth.

I. INTRODUCTION

The quest for the development of high strength and high performance concretes has increased considerably in recent times because of the demands from the construction industry. In the last three decades, supplementary cementitious materials such as fly ash, silica fume and ground granulated blast furnace slag have been judiciously utilized as cement re-placement materials as these can significantly enhance the strength and durability characteristics of concrete in comparison with ordinary Portland cement (OPC) alone, provided there is adequate curing. Fly ash addition proves most economical among these choices, even though addition of fly ash may lead to slower concrete hardening. However when high strength is desired use of silica fume is more useful however, this product is rather expensive. Concrete is one of the most versatile building materials. Concrete is composite material which consists of cement, coarse aggregate, fine aggregate and water in required proportions. Concrete is a material which used for the purpose of construction in now a days.

The cenosphere (spherical shape) improves the flow capacity in most applications and provides an even distribu-tion of the composite matrix filler material. Cenospheres are 75 percent lighter than other commonly used minerals as fillers or extender. It is possible to use them in dry or wet slurry form due to the natural properties of the cenosphere. Cenosphere is easy to manage because of its inert properties and has a low surface area-to-volume ratio and is not influenced by liquids, solvents, alkalis or acidsetc.These hollow spheres used as an extender for plastic compounds and are compatible with thermoplastics, latex,polyesters, plastisol's, epoxies, phenolic resins and urethanes. Synthetic cenosphere foams have shown superior mechanical properties compared to those fabricated with microspheres.

Silica fumes (SF) or calcined kaolin or other type of pozzolan produced by calcina-tion has the capability to replace silica fume as an alternative material. In India SF can be produced in large quantities, as it is a processed product of kaolin mineral which has wide spread proven reserves available in the country. At present the market price of SF in the country is about 3 - 4 times that of cement.

The present project involves a comprehensive laboratory experimentation study for the application of new waste materials in the preparation of concrete. The main objective of investigation is to study the strength behaviour i.e.

compressive strength and impact re-sistance of concrete with different percentages replacement of cement with Cenosphere and Silica fume.

The objective of the present study was to investigate experimentally the properties of Concrete with the following test results

1. Workability
2. Compressive strength
3. Flexure strength
4. Tensile strength

Objective of the research is to study the beneficial utilization of industrial waste as the cement replacement in construction work and to evaluate the optimum proportion of cenosphere as a beneficial replacement with cement in cement concrete.

II. REVIEW OF LITERATURE

A lot of work has been done to explore the benefits of using pozzolanic materials in making and enhancing the properties of concrete. A few inquiries were recorded concerning the physicaland mechanical properties of polymer and alloy compositesreinforced by fly ash cenosphere.

Sampathkumaran P et al have carried work on fly ash cenosphere reinforced different polymer composites, and they found that improved properties of both physical and mechanical properties with respect high density poly ethylene (HDPE) and low density poly ethylene (LDPE) polymer composites.

Divya VC et al have carried out work on the composite, with a high density polyethylene, cenosphere an multiwall carbon nanotubes (MWCNT), and they found that these composites showed better mechanical properties than the composites without cenosphere and MWCNT.The addition of cenosphere and MWCNT increase theflammability property of the composite.

Jalageri HB et al have prepared the cenosphere/multi wall carbon nano tubes reinforced polymer composites, and they found that the composite with 0.5 wt. % exhibits higher impact strength, and for 0.1 to 0.2 wt. % of MWCNT were found good flexural and tensile properties.

III. MATERIALS AND METHODS

The experimental investigation work is started with various tests on the constituent materials. The constituent materials are given below.

1. Cement
2. Coarse aggregate
3. Water
4. Cenosphere
5. Silica fume

Cement

Ordinary Portland cement of 43 grades manufactured by Shree Ultratech Cement was used throughout the Experimental investigation. The quality of the cement was confirming to IS 8112:1989 was used in the field.

Fine Aggregate

Fractions from 4.75 mm to 150 microns are termed as fine aggregate. Locally available river sand passed through 4.75mm IS sieve is applied as fine aggregate conforming to the requirements of IS 383:1970.

Coarse Aggregate

Coarse aggregate shall be of hard broken stone of granite shall be of hard stone, free from dust, dirt and other foreign matters. The stone ballast shall be of 20mm and down and should me retained in 5mm square mesh and well graded such that the voids do not exceed 42 percent. Aggregate most of which is retained on 4.75-mmIS Sieve and containing only so much finer material as is permitted for the various types described in this standard.

Cenosphere

The Fly Ash Cenosphere is obtained from the coal power plants in the form of hol-low spherical particles by burning the coal. Fly Ash Cenosphere was started to use in early as lightweight filler material in producing composites of cementitious and at present many researchers are focusing on use of FAC as filler in polymer and metals. These particles are hollow, empty and strong and are made up of silicon dioxide aluminium oxide and iron oxide. Cenosphere compatibility, especially in cements and other building materials, such as wall coatings and composites, and also used in a wide range of other items, including sports equipment, insulation, vehicles, marine crafts, paints, and fire and heat protection devices. Due to lower production costs of cenosphere often replace mined materials. Cenosphere will support the finished product properties by increasing electrical insulation, durability and better sound proofing.

Silica fume

Silica fume is a byproduct in the reduce of high-purity quartz with coke in electric arc furnaces in the manufacture of silicon and ferrosilicon alloys. Micro silica consist of fine element with a surface area on the order of 20,000 m^2/kg when particular by nitrogen adsorption techniques, with particle just about one hundredth the size of the average cement Because of its excessive fineness and high silica content, micro silica is a very efficient pozzolanic material particle. Addition of silica fume also decrease the permeability of concrete to chloride ions, which protect the reinforcing steel of concrete from corrosion, especially in chloride-rich environment such as coastal region. It has been reported that the pozzolanic reaction of silica fume is very important and the no evaporable water content decreases between 90 and 550 days at low water /binder ratios with the addition of silica fume.

IV. MIX DESIGN

The property of workability, therefore, becomes of vital importance. The mix design is done as per IS 10262-2009. Percentage dosage of super plasticizer (high range water reducers) is an additional parameter to be considered for designing an OPC mix. Percentage dosage of super plasticizer was fixed as per the mix design method described in IS 10262-2009. Mix proportion was arrived through various trial mixes. The grade of concrete prepared for the experimental study was M30.

V. RESULTS AND DISCUSSIONS

This session provides an outline of the experimental results and endeavours to draw some conclusions. The take a look at result covers the workability, strength properties and sturdiness properties of concrete with and without admixtures. The results of the experimental investigation on Silica fume and Cenosphere concrete wherever Silica fume and Cenosphere has been used as partial replacement of cement in concrete mixes. On commutation cement with completely different percentages of Silica fume and Cenosphere the workability, compressive strength is studied the compressive strength, split tensile strength and flexural strength for various mixes then studied.

REPLACEMENT DETAILS

The replacement details of Cenosphere and Silica fume has been given in the below table. The replacement of cement percentages by 0, 10, 20, 30% with Silica fume and 0, 2, 4, 6% Cenosphere and for getting optimum percentage

5.2 VARIATION OF SLUMP VALUES FOR PERCENTAGE REPLACEMENT OF CENOSPHERE

Slump test was carried out to measure the workability of various mixes. The worka-bility of various mixes was assessed as per the IS 1199:1959 specification. The minimum workability for 30% replacement of Silica fume concrete may be due to the lesser fine parti-cle size of cement which can result in higher water consumption thereby reducing workability. 10%replacement mix has high workability compared to other mixes which may be due to the particle size of Silica fume is lesser than cement.

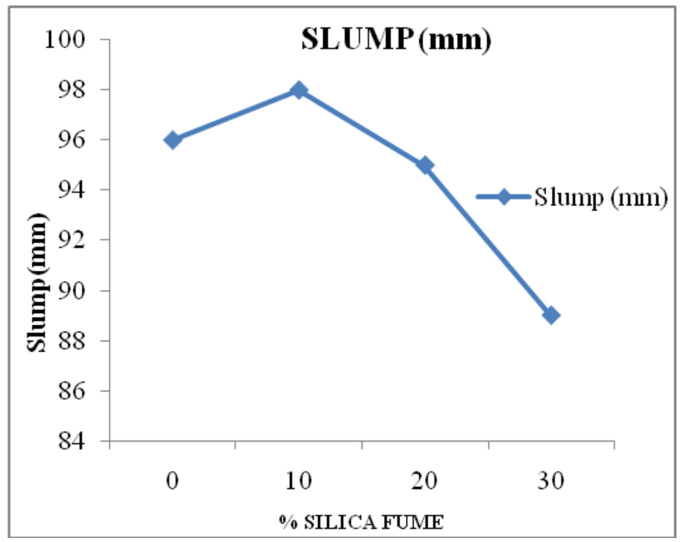

Fig 51: Plot shows the Variation of Slump Values for % replacement of Silica fume

5.3.1 COMPRESSIVE STRENGTH

The main function of the concrete in structure is mainly to resist the compressive forces. When a plain concrete member is subjected to compression, the failure of the member takes place, in its vertical plane along the diagonal. The vertical cracks occur due to lateral tensile strain. A flow in the concrete, which is in the form of micro crack along the vertical axis of the member will take place on the application of axial compression load and propagate further due to the lateral tensile strain.

Cubes are prepared of size 150 mm x 150 mm x 150 mm are checked for compressive strength. The specimens tested for 7, 14 and 28 days. The specimen were tested for compressive strength parallel to the plane of the board by applying increasing compressive load until failure occur. The arrangement of load is applied to the specimen by placing the specimen length vertical between the surfaces of the testing machine. Prior to that, measurement for the thickness and width was carried out in order to get the values of cross section area for the test specimens.

Cube compressive strength = loadarea

Where
Load = Load at failure of cube in N
Area = Application area = 150mm *150mm= 22500 mm^2

Fig 5.2: Compressive Strength Testing machine

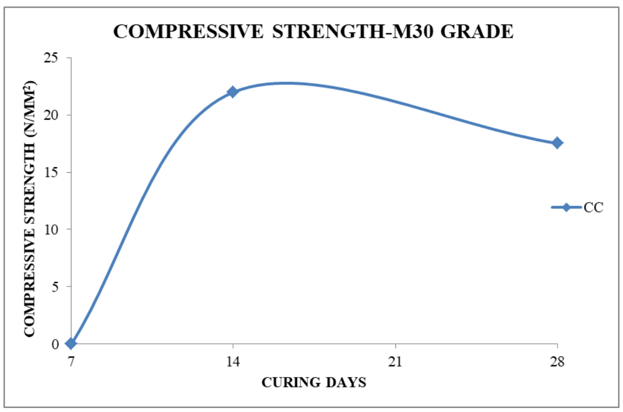

Fig 5.3: Plot shows the Variation of Compressive strength of conventional concrete

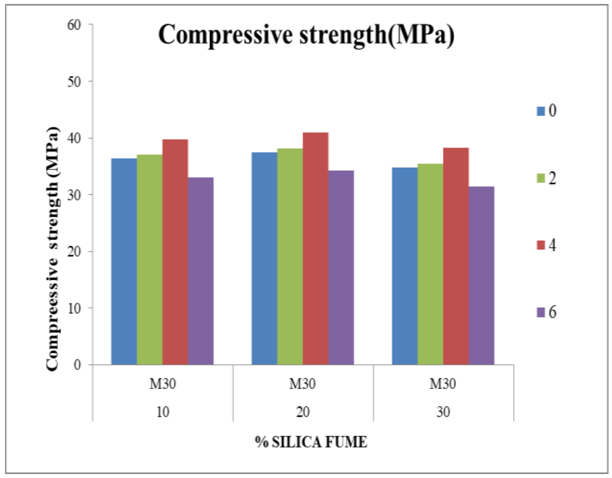

Fig 5.4: Plot shows the variation in compressive strength for different percentages of Cenosphere at 10% Silica fume-M30 Grade

The significance of test results of obtained from the average of three samples. It is observed from the results that the specimens containing particles show an increase in compressive strength when compared with the conventional concrete. The results exhibits that the concrete modified by 20% Silica fume and of 4% Cenosphere enhances the compressive strength compare to Normal concrete for 28 days. The enhancement of compressive strength of concrete can be mainly due to that Nano particles act as nuclei in promoting the cement hydration and filling up of pores to increment in the compressive strength of concrete. The influence of Cenosphere particle and Silica fume in concrete improves the low early age compressive strength in concrete.

5.3.2 SPLIT TENSILE STRENGTH

The size of specimens 150 mm dia and 300 mm length was used and the specimens were cured in normal water. Concrete specimen cubes are used to determine compressive strength of concrete and were tested as per as per IS 516 (1959) and IS 5816 (1999).

Table shows variation of Split tensile strength for conventional concrete

S.No	**Curing Days**	**Split Tensile Strength, (MPa)**
1	7 Days	2.51
2	14 Days	3.15
3	28 Days	3.73

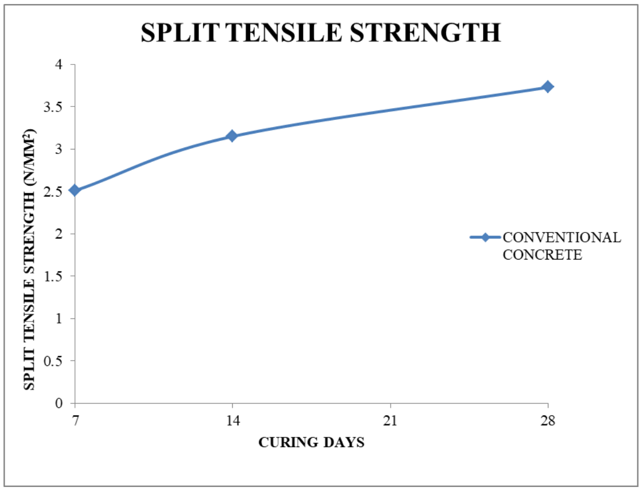

Fig 5.5: Plot shows the Variation of Split tensile strength of conventional concrete-M30 Grade

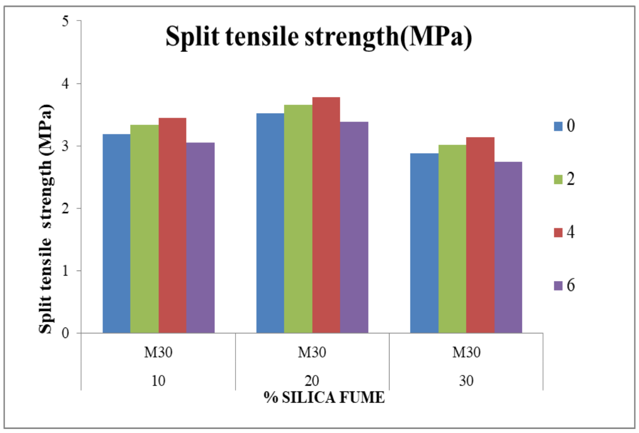

Fig 5.6: Plot shows the summarized results of split tensile strength for different percentages of Cenosphere and Silica fume

The significance of test results of obtained from the average of 3 samples. It is observed from the results that the specimens containing Nano particles show an increase in split strength when compared with the conventional concrete. The results exhibits that the concrete modified by 20% Silica fume and of 4% Cenosphere shows an enhancement in split tensile strength of concrete.

5.3.4FLEXURAL STRENGTH

In the flexural strength test theoretical maximum tensile stress reached at the bottom fibers of the test beam is known as the modulus of rupture. When concrete is subjected to bending stress, compressive as well as tensile stresses are developed at top and bottom fibers respectively. If the largest nominal size of aggregate does not exceed 20mm, the dimension of specimen may be 150mm×150mm×700mm.

6.5.1 VARIATION OF FLEXURAL STRENGTH FOR DIFFERENT MIXES AND GRADES

The Flexural strength of the concrete mix for different grades with partial replacement of cement by Silica fume and Cenosphere respectively showed higher Strength against splitting after 7 , 14 and 28 days for M30 grade.

Table 6.1shows variation of flexural strength for conventional concrete

S.No	Curing Days	Flexural Strength, (MPa)
1	7 Days	2.69
2	14 Days	2.91
3	28 Days	3.21

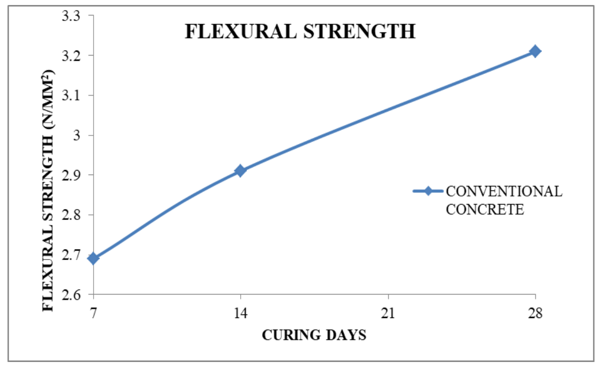

Fig 5.7: Variation of Split tensile strength of conventional concrete-M30Grade

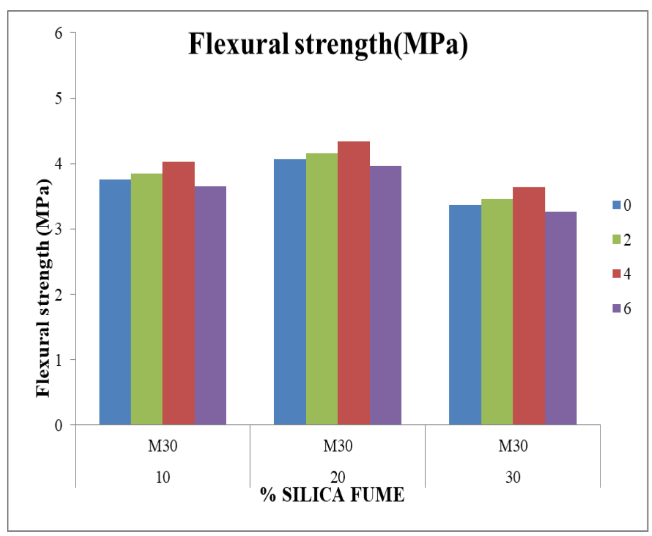

Fig 5.8: Plot shows the summarized results of flexural strength for different percentages of Cenosphere and Silica fume

The significance of test results of obtained from the average of 3 samples. It is ob-served from the results that the specimens containing Nano particles show an increase in flexural strength when compared with the conventional concrete. The results exhibits that the concrete modified by 20% Silica fume and of 4% Cenosphere shows an improvement results in flexural strength compare to normal concrete for 28 days for M30 grade. The enhancement of split tensile strength of concrete can be mainly due to that Nano particles act as nuclei in promoting the cement hydration and filling up of pores to increment in the flexural strength of concrete. The influence of Cenosphere particle and Silica fume in concrete improves the low early age flexural strength in concrete.

VI. CONCLUSIONS

- This experiment shows that, partial replacement of cement with Silica fume and cenosphere gives good results. It will improve durability and reduce pollution, we studied the require properties of concrete like workability, compressive strength, flexural strength and compared with the normal standard concrete. This experiment gives satisfactory results, so these results are enhancing usage of Silica fume and cenosphere in concrete, the following conclusions were made:
- It has been observed that by the incorporation of Silica fume as partial replacement to cement and Cenosphere as addition in fresh and plain concrete increases workability up to 20% and then reduced to 30%.
- It is noted that replacement of cement with Silica fume and cenosphere gives satisfactory results.
- It is clearly observed that the concrete modified by 20% Silica fume and of 4% Cenosphere enhanced the compressive strength 5% with that of Normal concrete for 28 days for like M30 grade concrete. The compressive strength for the mix is 38.43 N/mm2.
- The influence of Cenosphere and Silica fume in concrete improves the low early age compressive strength in concrete.
- The split tensile strength results exhibits that the concrete modified by 20% Silica fume and of 4% Cenosphere shows nearly same results like split tensile strength of Normal concrete for 28 days M30 grade concrete.
- From the results it is noted that the concrete modified by 20% Silica fume and of 4% Cenosphere shows prominent results and the improvement is about 35% with that of Normal concrete for 28 days M30 grade concrete. The flexural strength for the mix is 4.34 N/mm2.
- It is evident from the present investigation, influence of Silica fume and Cenosphere will improves the micro structure as well as decrease the free calcium hydroxide concentration by consuming it through a pozzolanic reaction.
- The use of Silica fume and Cenosphere combined is economic when compared to cement in concrete. Likewise saves a great deal of waste disposal problems and reduces the cement price rise and intensities of CO2 release by the cement production.

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