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ENHANCING PROPERTIES OF CONCRETE BY USING FLYASH AND NANO SILICA AS PARTIAL REPLACEMENT OF CEMENT

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ABSTRACT:

Concrete is most commonly used construction material and it consumes huge amount of cement. Manufacturing of cement produces increasing CO2 emission which is harmful to the environment. Method used to reduce cement content in concrete is use of Fly ash and Nano silica as a partial replacement of cement in concrete. Nanotechnology is one of the most promising areas of science. The use of Nano materials in concrete is new revolution. Nano silica is presently used in concrete to modify its strength properties. In this study strength properties such as Compressive strength, split tensile strength, Flexural strength of M25 grade of concrete with use of Nano silica 1.5%, 3%, 4.5% and 6%, 10% constant rate of fly ash as partial replacement of cement and strength obtained is comparable to the conventional concrete. It was observed from the experimental study that concrete composites with superior properties can be produced using combination of Nano silica and fly ash. In the project casting of cubes of size 150*150*150 mm and cylinder of size 150*300 mm are cast for finding compressive and split tensile strength. The cubes and cylinders are test at 7, 14, 28 days. The beam of size 100 *100 *500 mm and tested at 28 days. concrete in which cement is replaced with fly ash and Nano-silica is compared with conventional concrete.

1.0 INTRODUCTION

Concrete is the most widely used construction material in the world. It is mixture of cement, coarse aggregate, fine aggregate and water. Fresh concrete is freshly mixed material which can be molded into any shape. Cement is the main ingredient in concrete. In manufacturing process of Portland cement, clinker in incinerated at about 1300ºC to 1500ºC resulting in emission of huge amount of CO_2 into the atmosphere. Huge amount of CO_2 emission causes very bad effects on the environment. So, nowadays a key issue for the construction industry is the need for sustainable concrete. Since last few decades concrete technology has experienced substantial advances, resulting in innovative use of supplementary additives and cementations materials has developed new generations of concrete with improved properties. So in present work cement is replaced by Nano-silica Fly ash to reduce cement content in concrete.

NANO SILICA

Silicon dioxide nanoparticles, also known as silica nanoparticles or nano silica, in nature, silica makes up quartz and the sand. It is the first Nano product that replaced the micro silica. Advancement made by the study of concrete at Nano scale has proved Nano silica much better than silica used in conventional concrete.

BENFITS OF THE NANO SILICA

Addition of nano silica in concretes and mortars results in more efficient hydration of cement. More strength is developed which helps in reducing the cement requirement. Nano silica improves the micro structure and makes concrete more impermeable and more durable. As it produces a dense concrete, compressive strength is increased.

In addition, it reduces segregation and bleeding and is ideal for use in High Performance Concrete (HPC) and Self Compacting Concrete (SCC). Further, when self-compacting concrete is used in the practical construction, the addition of nS reduces the form work pressure addition of Ns.

OBJECTIVES OF THE PROJECT

The main objective of the project is to determine the improvement of strength of concrete by incorporating fly ash and Nano silica. To study the fracture behavior of concrete by replacement of fly ash and Nano silica.

- To study the compressive strength and split tensile strength properties of concrete with Nano Silica and Fly Ash in certain proportions.
- To utilize volume of Nano silica 1.5%, 3%, 4.5%, 6% and 10% of constant rate of fly ash respectively.
- To compare the strength of concrete between partially replaced fly ash and Nano silica.
- To compare fracture energy of concrete by replacing fly ash and Nano silica.

ADVANTAGES OF NANO SILICA&FLY ASH

By using FLY ASH and NANO SILICA nano concrete we can reduce the emission of carbon dioxide during cement production and manufacturing.

Sand can be used in effective manner to produce the concrete.

- The fly ash usage will be reduced the amount of environmental pollution.
- By the using of nano silica it gives early age of concrete and also increase the properties like High ductility, self-crack controlling, low electrical resistivity, self-sensing capabilities, self-healing.
- It also increases the strength of concrete 10% to15%.
- Nano silica based on concrete give more strength then the conventional concrete.

2.0 LITERATURE REVIEW:

In this chapter the works of various authors on the use of Nano material's in concrete has been discussed in brief. A great number of researches have been performed to understand the nature of nano material's and their effect on the properties of concrete. A number of Research & Development work dealing with the use of nano material's like Nano silica, colloidal Nano Silica (CNS), Al2O3, TiO2, ZrO2,Fe2O3, carbon nanotubes (CNT) in cement based materials are discussed in the literature.

[1] H. Li et. al. (2004) experimentally investigated the mechanical properties of nano-Fe2O3 and nanoSiO2 cement mortars and found that the 7- and 28-day strength was

much higher than for plain concrete. The microstructure analysis shows that the nanoparticles filled up the pores and the reduced amount of CA (OH) 2 due to the pozzolanic reaction.

[2] Tao Ji (2005) experimentally studied the effect of Nano SiO2 on the water permeability and microstructure of concrete. The findings show that incorporation of Nano SiO2 can improve the resistance to water of concrete and the microstructure becomes more uniform and compact compared to normal concrete.

[3] H. Li et.al. (2006) studied the abrasion resistance of concrete blended with Nano particles of TiO2 and SiO2 Nano particles along with polypropylene (PP) fibers. It was observed that abrasion resistance can be improved considerably by addition of Nano particles. the combined effect of PP fiber + Nano particles shows much higher abrasion resistance than with Nano particles only.

[4] B.-W Jo et. al. (2007) studied the characteristics of cement mortar with Nano SiO2 particles experimentally and observed higher strength of these blended mortars for 7 and 28 days. The microstructure analysis showed that SiO2 not only behaves as a filler to improve microstructure, but also as an activator to the pozzolanic reaction.

3.0 MATERIALS AND METHODS

CEMENT

Cement is most important ingredient and adds as binding material. Cement is obtained by palavering clinker formed by raw materials primarily comprising of lime (CaO), silica (SiO_2), alumina (Al_2O_3), and ferric oxide (Fe_2O_3) along with some miner oxide. The characteristic behavior of this concrete mass in a given condition depends on type, quality and quantity of cement.

Table: 3.1 Properties of cement

S.No	Characteristics	Value obtained
1	Normal consistency	33%
2	Initial setting time	30 min
3	Final setting time	600 min
4	Specific gravity	3.11
5	Fineness	4.8

Aggregates:

Aggregate is an important ingredient of concrete since it occupies about 70-75%volume concrete, relatively cheap as well as it quality effects the durability and structural behavior of concrete members. It is said that the strength of concrete is the strength of its aggregate. It is corrected to considerable extent as this is the chief material that gives strength the concrete.

Fine Aggregate

Sand is an inert occurring material of size less than 4.75mm. It is used as a material of construction not only as filling and as a porous foundation blanket but also to a wide extent as a filtering medium and as a constituent of mortars and concrete. In view of those important applications sand is described as naturally granular material of a certain grain size irrespective of shape of grains, thus uniformity and their mineral composition

Table 3.2 Properties of fine aggregate

S. No	Characteristics	Value obtained
1	Type	Uncrushed
2	Specific gravity	2.65
3	Total water	0.65%
4	Fineness modulus	2.5

Nano Silica

Silicon dioxide nanoparticles, also known as silica nanoparticles or Nano silica, in nature, silica makes up quartz and the sand. It is the first Nano product that replaced the micro silica. Advancement made by the study of concrete at Nano scale has proved Nano silica much better than silica used in conventional concrete.

Figure: 3.1 Nano Silica

Table 3.3 Properties of Nano silica

S.No	Characteristics	Value obtained
1	Active Nano content	30-32%
2	pH	9-10
3	Specific gravity	1.20-1.22
4	Particle size	17nm

Procedure or making fly ash and nano silica in concrete

In the laboratory first fly ash on the aggregate were mixed together and later Nano silica and aggregates were mixed together.

- The aggregates were prepared in saturated surface in dry conditions.
- The mix was 150*150*150 mm steel mould cubes and 150*300 mm steel mould cylinders.
- Immediately after casting, the samples were covered by a film to avoid the loss of water due to evaporation.
- Then the cubes and cylinders from the mould and then placed in the curing in room temperature.

- The compressive strength test studied on cubes and cylinders with varying percentages of Nano silica and constant percentage of fly ash at 7, 14, 28 days and results are tabulated.

Casting of test specimen In present study the specimen of standard cubes of size 150 X 150 X 150mm, cylinders of size 150mm diameter and 300mm length are casted Cube specimens were tested after 7, 14, 28 days of curing. cylinder specimens were tested after 7,14,28 days of curing. Beam tested after 28 days.

Mixing:

Measured quantities of coarse aggregate and fine aggregate were spread over an impervious concrete floor. The dry OPC were spread out on the aggregate and mixed thoroughly in dry state turning the mixture over and over until the uniformity of color was achieved. Water was measured exactly and it was thoroughly mixed to obtain homogenous concrete. The mixing shall be done for 10 to 15 minutes.

Figure: 3.2 Mixing of Concrete

Curing: The test specimens were stored in a place free from vibration in moist air at 90% relative humidity and at temperature of 27+/ for 24 ½ hours from the time of addition of water to dry ingredients. After 24 hours the specimens are demoded and immediately immersed in clean, fresh water tank for period of 7, 14, 28 days

Figure 3.3 Curing of cubes & cylinders

SPECIMEN DETAILS

Cubes of 150*150*150 mm and cylinders 150*300mm were cast. Specimen details are shown in tables

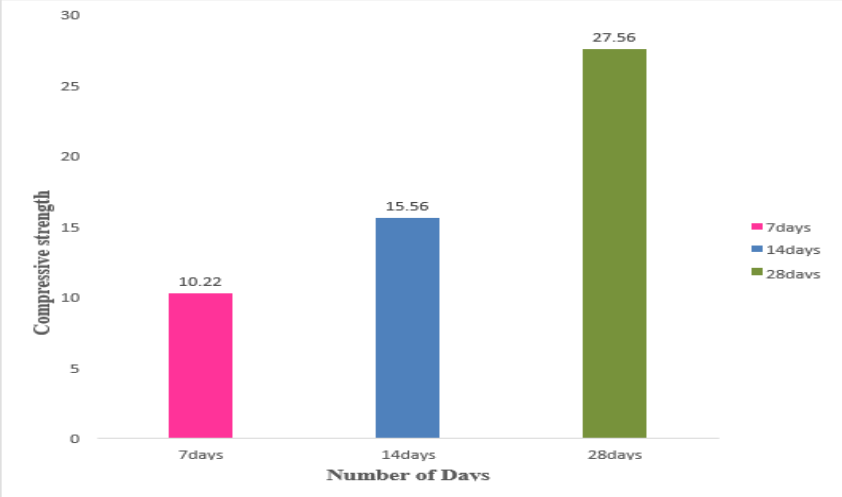
Table:3.4 Fly ash& nano silica replaced cement specimen details

Grade of concrete	Fly ash replacement	Nano silica replacement	7, 14, 28datys		
			No of cubes	No. of cylinders	No. of beams
M25	10%	1.5%	15	15	5
	10%	3%			
	10%	4.5%			
	10%	6%			

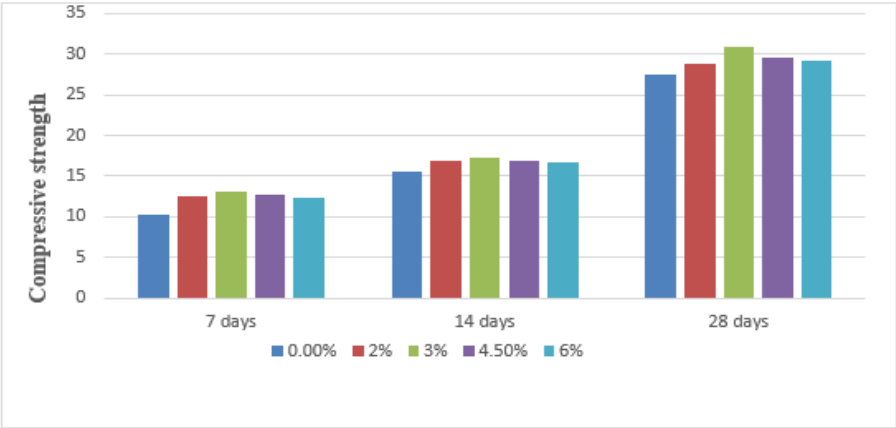
4.0 RESULTS AND TESTS

COMPERESSIVE STRENGTH TEST

In compression testing machine, the top surface of machine is fixed and load is applied on the bottom surface of specimen. The rate of loading is gradual and failure (crushing) load is noted and compressive strength is calculated. The compressive strength of specimens is determined after 3,7 and 28 days of curing with surface dried condition. Three specimens are tested for typical category and the mean compressive strength of three specimens is considered as the compressive strength of the specified category.



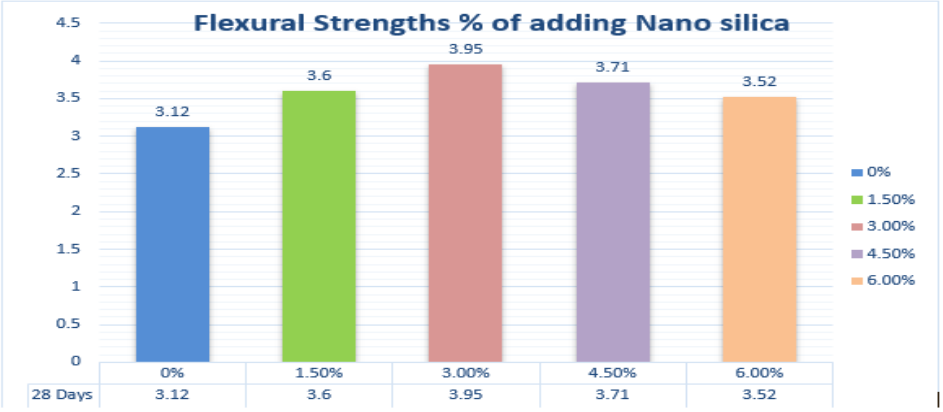
Graph: compressive strength for the conventional concrete in cubes in 7, 14and 28 days



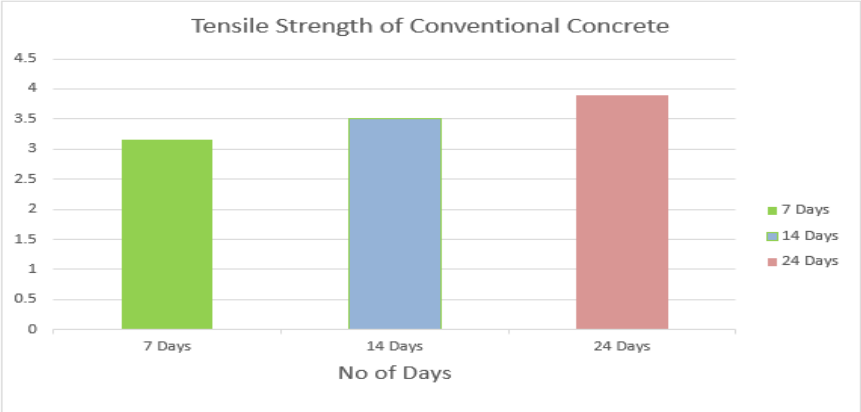
Graph: Compressive strength of the concrete by using 1.5%,3%,4.5%,6%nano silica&10%fly ash 3, 7&28 days

Flexural strength test on concrete:

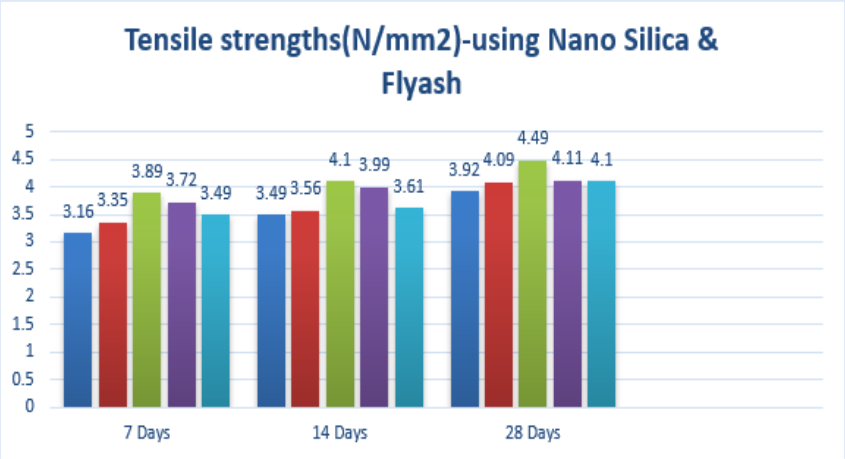
This test was carried out for determining the Flexural strength of concrete. The method of testing was done as per IS 516-1959. The Universal testing machine with 200 tones capacity was used for testing the specimens. Test specimen's prisms in shape were 100 × 100 × 500 mm, if the largest nominal size of the aggregate does not exceed 19 mm in the specimen.



Graph: Flexural Strengths % of adding Nano silica



Graph: Tensile Strength of Conventional Concrete



Graph: Tensile strengths(N/mm2)-using Nano Silica & Fly ash

CONCLUSION:

This chapter is summery of the present study, the major conclusion of using Nano silica and fly ash in concrete. The results of the experimental investigation indicate that combination of fly ash and Nano-silica can be used as Ordinary Portland cement replacement for concrete preparation. Using the test results, it can be concluded that with the increase in the percentage of Nano-silica for constant percentages of fly ash, the various strength properties of concrete are increased up to 3% of Nano silica and with further increase in the Nano-silica the properties of concrete are decreased.

The various strength characteristics of concrete can be improved by the combined application of 3% nano-silica and 10% fly ash content. It can also be concluded that the cement content can be reduced without compromising the strength of concrete by the use of fly ash and nano-silica combination.

- The compressive strength was found 2.36%, 2.96%, 2.53% and 2.2% higher than that of conventional concrete when the cement is replaced by 1.5%, 3%, 4.5%, 6% by Nano-silica respectively and 10% Fly ash at constant rate for the age of concrete 7 days.
- The compressive strength was found 2.31%, 3.66%, 2.44%, and 2.05% higher than that of conventional concrete when the cement is replaced by 1.5%, 3%, 4.5%, 6% by nano-silica respectively and 10% Fly ash for the age of concrete 14 days.
- The compressive strength was found 3% lower than that of conventional concrete when the cement is replaced by 6% nano-silica and 10% Fly ash for the age of concrete 28 days.
- The compressive strength was found 4%, 11.94%, 7.99%, and 4.55% higher than that of conventional concrete when the cement is replaced by 1.5%, 3%, 4.5%, 6% by Nano-silica respectively and 10% Fly ash for the age of concrete 28 days.
- Split Tensile strength of nano-silica and Fly ash-based concrete was higher by 2.35%, 29.58%, 15.96%, and 3.66% than that of conventional concrete for the replacement of 1.5%, 3%, 4.5%, 6% at the age of concrete 7,14,28 days. Split Tensile strength was decreased by 16.23% than that of conventional concrete.

Flexural strength was found 3.6%,3.95%,3.71%,3.52% higher than the conventional Nano-silica based concrete gives more strength than conventional concrete at the age of 28 days.

REFERENCES

1. A.Boshehrian and P.Hosseini, (2011), "Effect of nano-SiO2 particles on properties of cement mortar applicable for Ferro cement elements." Concrete research letters.
2. L. Senff, D.M. Tobaldi, S. Lucas, D. Hotza, V.M. Ferreira, J.A. Labrincha, (2012), "Formulation of mortars with nano-SiO2 and nano-TiO2 for degradation of pollutants in buildings". Composites: Part B 44 (2013) 40–47
3. HongjianDua, Suhuan Du, Xuemei Liu (2014), "Durability performances of concrete with nano-silica". Construction and Building Materials 73 (2014) 705–712
4. MainakGhosal and Arun Kr Chakraborty (2015), "A Comparative Assessment of Nano-SiO2 & Nano-TiO2 Insertion in Concrete." European Journal of Advances in Engineering and Technology, 2015, 2(8): 44-48
5. Gambhir, "Concret Alaa M. Rashad (2013), "Effects of ZnO2, ZrO2, Cu2O3, CuO, CaCO3, SF, FA, cement and geothermal silica waste nanoparticles on properties of cementations materials A short guide for Civil Engineer." Construction and Building Materials 48 (2013) 1120–1133