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Experimental Evaluation of Nano Composite Concrete

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ABSTRACT:

The development of construction materials technology, particularly concrete is growing very rapidly in the presence of nanotechnology. Nanotechnology is the science of engineering that deals with the particle which are less than 100 nm in size. Hence here Nano silica is used as an additive to fill up the deviation, and it is possible because the silica(S) in the sand reacts with calcium hydrate in (CH) the cement at Nano scale to form C-S-H bond and it improves the strengthening factor of concrete. In this paper an attempt has been made to carry out an experimental investigation on concrete by replacing cement with 30%, 40% and 50% fly ash and an additive of 3% nano silica. The compressive strength, split tensile strength and flexural strength of concrete is found and is compared with Portland Pozzolana Cement (PPC).

INTRODUCTION:

Concrete technology is a multidisciplinary area of research where nanotechnology potentially offers the opportunity to improve the properties of concrete to suit the specific requirements. Addition of nano materials to concrete can lead to significant improvements in the strength and life of concrete. Nanotechnology is the science of engineering that deals with particle which are less than 100 nm in size. The development of construction materials technology, particularly concrete is growing very rapidly in the presence of nanotechnology. Nano technology applied to concrete includes the use of nano materials like nano silica, nano fibers, etc.

By adding nano materials, concrete composites with superior properties can be produced. Ordinary Portland cement (OPC) is the main ingredient of concrete but the production of OPC releases about 5-7% of carbon dioxide into atmosphere hence there is a need to reduce the use of OPC in concrete. The use of flyash as partial replacement of cement is well researched and is widely used. The use of flyash is limited to a maximum of 25 to 30% by weight as a partial replacement of cement.

Although the use of flyash is limited the high volume flyash is studied where the properties are inferior compared to the low volume flyash hence there is a deviation in strength of concrete. In order to overcome the deviation Nano silica is used as an additive.

EXPERIMENTAL INVESTIGATION:

The various materials used for the experimental investigation and various tests carried out are presented in this chapter.

FLYASH:

Fly ash is most commonly used as a pozzolan in PCC applications. Cement is the most costly and energy-intensive component of concrete. The unit cost of concrete can be reduced by partial replacement of cement with fly ash. As per ASTM C 618 – 1993[17] there are two classes of fly ash namely class F and class C. Class F fly ash is produced from burning anthracite or bituminous coal and is pozzolanic in nature and class C is obtained from lignite or sub-bituminous coal. Class C fly ash possesses both pozzolanic and self-hardening property.

Hence, it is necessary to characterize the material scientifically to utilize it in different applications. The main chemical compounds of class F fly ash are silica, alumina and iron oxide. Other minor constituents include oxides of calcium, magnesium, titanium, sulphur, sodium and potassium. Class C fly ash contains relatively higher proportion of calcium oxide and lesser proportion of silica, alumina and iron oxide than class F fly ash.

The pozzolanic effect is the main effect of Fly ash, which states that the unfixed SiO2 and Al2O3 in FA can be activated by Ca (OH) 2 product of cement hydration and produce more hydrated gel. Since the gel produced from pozzolanic action can fill in the capillary in concrete.

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S.No	properties	Values in
1	$Si0_2$	35.4
2	Al_20_3	17.5
3	Fe_20_3	5.3
4	ea0	26.1
5	Mg0	4.6
6	$S0_3$	2.8

NANO SILICA:

Nano silica is one of the silica fines with high potential as cement replacement and as concrete additive. There are different methods to produce nS products. One production method is based on Sol-gel process organic or water route at room temperature. In this process, the starting materials like Na2Sio4 and organo metallic's like TMOS/TEOS are added in a solvent and then the pH of the solution is changed reaching the precipitation of silica gel. The produced gel is mixed and filtered to become a Xerogel. This is further dried and burned or dispersed again with stabilized agent (Na, K and NH3) to produce a concentrated dispersion with 20 to 40 % solid content suitable for use in concrete. There are other methods like vaporization of silica between 1500 to 2000 ºC reducing quartz in an electric arc furnace, biological method, precipitation method etc.

Nano-Silica could significantly increase the compressive strength of concretes containing large fly ash volume at early age, by filling the pores between large fly ash and cement particles. Nano-silica decreases the setting time of mortar when compared with silica fume micro silica and reduces bleeding water and segregation by the improvement of the cohesiveness. Concrete is a macro-material strongly influenced by its nano-properties.

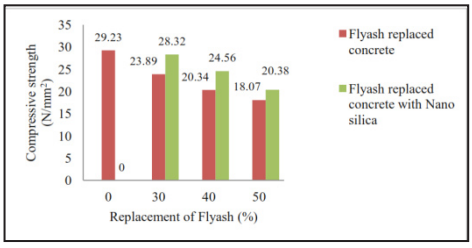
The addition of nano-silica (SiO2) to cement based materials can control the degradation of the calcium-silicate hydrate reaction caused by calcium leaching in water, blocking water penetration and leading to improvements in durability. Nano silica can improve the performance of cement-based materials matrix through increased production of CSH gel due to pozzolanic reaction and reduced amount of Ca (OH)2 Nano Silica used in this project is brought from Ambattur industrial estate. Below Figure shows Nano Flyash and Nano Silica.

MIX DESIGN:

Mix proportioning	Cement (Kg)	Water (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Fly ash (kg)
per m^3	276.	197.72	698.49	1132.80	118.29
per bag of cement	50	22.5	92.57	138.5	15
Ratio	1	0.45	1.85	2.77	0.30

RESULTS AND DISCUSSION:

The compressive strength of 150x150x150 mm cubes of M25 grade concrete with 0%, 30%, 40% and 50% of cement replaced with flyash and the same percentage of flyash replacement on an addition of 3% Nano Silica for 7 and 28 days respectively. It can be seen that the strength of concrete is reduced when the percentage of fly ash is increased. However there is an improvement in strength after adding nano silica. The percentage increase in compressive strength for 30%,40% and 50% cement replaced flyash concrete on addition of Nano silica of 3% after 28 days is 19%,21% and 13% to that of flyash replaced concrete.



Compressive strength comparison for 28 days

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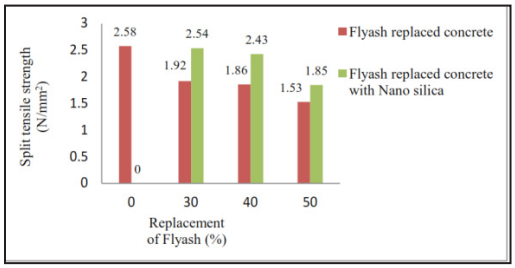
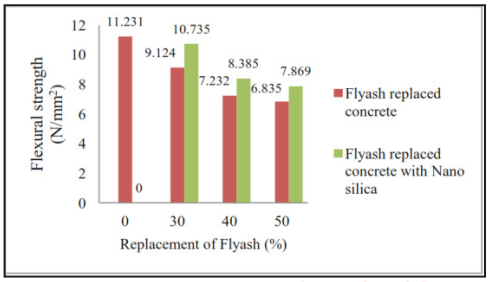


Split tensile strength comparison for 28 days



Flexural strength comparison for 28 days

CONCLUSION :

From the experimental work the following conclusions are drawn

» The strength of concrete is reduced when the percentage of fly ash is increased. However there is an improvement in strength after adding nano silica.

» The percentage increase in compressive strength for 30%,40% and 50% cement replaced flyash concrete on addition of Nano silica of 3% after 28 days is 19%,21% and 13% to that of flyash replaced concrete.

» The percentage increase in Flexural strength for 30%,40% and 50% cement replaced flyash concrete on addition of Nano silica of 3% after 28 days is 32%,30% and 21% to that of the flyash replaced concrete.

» The percentage increase in Split tensile strength for 30%,40% and 50% cement replaced flyash concrete on addition of Nano silica of 3% after 28 days is 18%,16% and 15% to that of the flyash replaced concrete.

» The use of fly ash in concrete reduces the cement content thereby reduction in carbon dioxide emission and becomes green concrete.

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