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Experimental Study on Nano Silica Concrete

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Abstract: Concrete is the most common material for construction. The total production depends upon the cement content only. Due to the usage, large amount of cement produces increasing the CO2emissions, to reduce the cement percentage in concrete mixes the nanosilica (nSiO2) is used as the replacement of the cement. The application of nanotechnology to concrete structures has added a new dimension to improving their properties. Due to their very small particle size, nanomaterials alter the microstructure and affect the properties of concrete. This study addresses the use of powdered nanosilica to improve the compressive strength of concrete. An experimental study was conducted by replacing cement with 0.5%, 1.0%, 1.5%. 2.0%, 2.5%, 3.0% and 3.5% for class M20 concrete (1:1.5:3) with a water cement ratio of 0.5 and 0.5% polycarboxylate superplasticizer. The tests carried out show a considerable increase in the initial compressive strength and splitting tensile strength of the concrete on the 7th, 14th and 28th days of curing. Increases in strength are observed and continue to decrease as the percentage of nanosilica increases to the limit.
Keywords: Concrete, Cement, Nano Silica, Compressive Strength, Tensile Strength, Workability.

I. INTODUCTION

The use of large amounts of cement is important to achieve higher compressive strength. The use of nano-SiO2 materials through percentage replacement of cement binders may lead to increased compressive strength and reduced contaminants in concrete. The use of very small amounts of nano-SiO2 can have a significant impact on concrete properties and characteristics. A detailed study of their microstructure is essential to understanding the reactions and behavior of nanoparticles. Fresh state properties (flowability and workability) are determined, for example, by particle size distribution (PSD), but cured state concrete properties such as strength and durability are also affected. Mixed grading and resulting particle packing. One of his ways to further improve packing is to expand the range of solid sizes. By including particles with a size of less than 300 nm. However, these products are synthesized in a rather complicated way, resulting in high purity and complex processes that are not viable in the construction industry. The aim of this study is to To provide practical application methods and models for applying the newly developed nS to concrete. This experiment is an attempt to explain the effect of nano-silica on the compressive strength of concrete by explaining the microstructure of concrete. The current experiment uses a mixed design based on the Indian standard code IS 10262-2009. The nano silica used is imported from a supplier. Admixture is strictly prohibited when designing mixtures. Moisture content was kept stable to allow better evaluation of different samples. Compressive strength measurements are taken at 7, 14 and 28 days.

II. LITERATURE REVIEW

1) MOHAMMADMEHDI CHOOLAEI et.al: In this study, the interaction of nano-SiO2 in cement-sand mortar was experimentally investigated. No additional water was used in the designed slurry accumulation. The results showed that the use of this nano-SiO2 shortened the curing time and stationary phase length of concrete. We are also studying the porosity of cements designed using nano SiO_2 showed a decrease in cement porosity as the amount of nano SiO_2 was increased in the investigated slurries.
2) MOUNIR LTIFIA ET.ALL: According to the authors, the properties of cement mortar containing nano-SiO2 were investigated experimentally. Unstructured or vitreous silica, the main component of pozzolans, interacts with calcium hydroxide formed by hydration of calcium silicate. Regarding the effect of nanoparticles addition on cement mortar paste performance, amorphous silica nanoparticles were incorporated in amounts of 3 and 10 wt% in the cement binder. The compressive strength of other mortars increases with increasing nano-SiO2 content. Nano SiO2 beliefs about curing time and consistency differ. Nano SiO2 accelerates the cement hydration process and thickens the cement paste.
3) Dr. SOMASEKHARAIAH et al.: Concrete is a commonly used building material that consumes natural resources such as lime, aggregate and water. In this study, concrete composites are replaced with industrial waste. In this study, research was conducted on the development of high-performance concrete using inorganic admixtures such as metakaolin and nanosilica as a feasibility study to determine the strength of concrete. Combine fractions are obtained from 0%, 10%, 20% and 30% cement and

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exchanged for metakaolin. Different water:cement ratios of 0.275, 0.325, and 0.375 and an aggregate ratio of 2.0 are used in this experiment. In this context, a series of 100 x 100 x 100 concrete cubes, 200 x 100 cylinders and 100 x 100 x 500 beams were poured with different mix ratios and cured for 7 and 28 days.

4) D.S Teja et. al: The nano silica is available in 10-50 nm as particle size. The 17nm particle size is used for the whole project. This paper aim is to study the mechanical properties of the specimen using the nano silica by replacement of the cement. The ratio in weight of the nano cement with respect to normal cement. The mortar specimen size is 70.6x70.6x70.6 mm. The concrete cube size is 150 x 150 x 150 mm was maintained and water cement ratio 0.40 was maintained throughout the project. The 0%, 1.5%, 3.5%, 5.5% and 7.5% of nano silica should be replaced with weight of the cement.

A review of many references shows the importance of this area of research. The results show that a range of nanomaterials such as SiO2, TiO2, Al2O3, colloidal nanosilica and metakaolin can be incorporated to improve concrete properties. Nano silica is used up to 2% by weight of cement. This study shows that the use of 0.5% of polycarboxylate superplasticizer improves the properties of mixed concrete in terms of flexural strength, compressive strength and tensile strength upto 3%. Apart from that, we can also increase the permeability of the sample by adding small amounts of nanomaterials. The current study deals with the incorporation of nano-SiO2 of more than 3% nano-silica particles in concrete.

III. MATERIAL AND METHODOLOGY

A. Water

The amount of water in concrete is an important factor in several new Controls curing properties. For these reasons, limiting and favoring water content in concrete is very important for constructability and service life.

B. Portland Cement

Cement is the most common type of cement, commonly used worldwide as a basic building block in concrete, mortar, stucco, and non-specialty mortars. Developed in Europe in the mid-19th century from various types of hydraulic lime, usually derived from limestone. It is a fine powder made by heating limestone and clay minerals to clinker in a kiln, pulverizing the clinker, and adding 2 to 3%.

C. Aggregates

Fine aggregates generally consist of natural sand or crushed stone with most particles smaller than 5 mm (0.2 in.). Coarse aggregates (Fig. 5-2) consist of one or a Aggregates for Concrete bination of gravels or crushed stone with particles predominantly larger than 5 mm (0.2 in.) and generally between 9.5 mm and 37.5 mm (3 ⁄8 in. and 11 ⁄2 in.). Some natural combination deposits, called pit-run gravel, consist of gravel and sand that can be readily used in concrete after minimal processing.

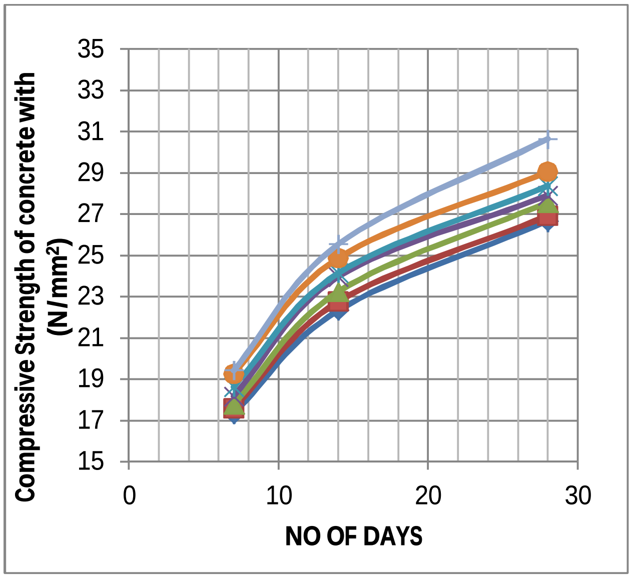
D. Nano Silica

Nanosilica produced by this technology is a very fine powder consisting of spherical particles or microspheres with a maximum diameter of 150 nm and a large specific surface area (15-25 m2/g). Using this technique, spherical nanoparticles can be obtained with a process efficiency of 88%. These particles were produced by feeding earthworms rice husks, a biological waste containing 22% SiO2. Finally, nS can be produced by precipitation method. Silica nanoparticles (SiNPs) or silicon dioxide are amorphous substances that have a spherical form. They can be produced in a variety of shapes and sizes, and the properties of their surfaces can be easily changed to suit several purposes.

IV. RESULT AND ANALYSIS

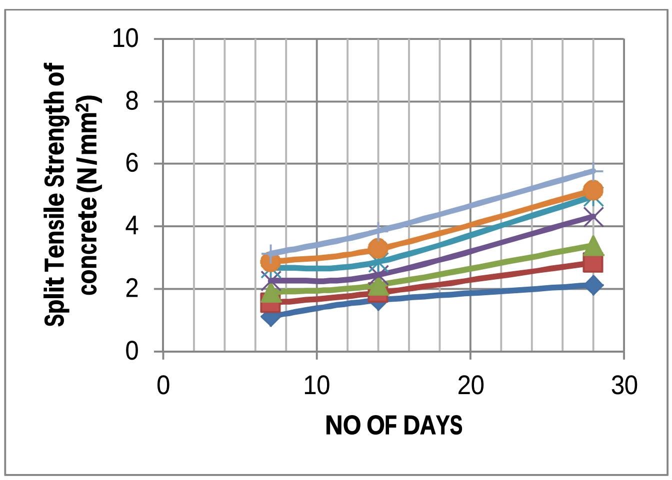
A. Compressive Strength Test

The combined Graph 1, compressive strength of various proportions by replacing cement with nano-silica. The material has been collected and used as a replacement of cement because it is having Pozzolana property. The proportions of nano-silica replaced cement with 0.5% of Polycarboxylate superplasticizers are taken as 0%, 0.5% 1.0%, 1.5%, 0.20%, 2.5%, 3.0% and 3.5% and compressive test result is 26.67N/mm^2, 26.92 N/mm^2 , 27.58 N/mm^2 , 27.91 N/mm^2, 28.37 N/mm^2, 29.05 N/mm^2, 30.65 N/mm^2 and 28.85 N/mm^2 respectively on 28th day of curing. The compressive strength of concrete using nano- silica increases as content of silica increases. The maximum result is by replacing 3% of cement by nano-silica is 19.43N/mm^2, 25.54N/mm^2 and 30.65 N/mm^2 on 7th, 14th and 28th day of curing.



B. Tensile Strength

The combined Graph 16, Split Tensile strength of various proportions by replacing cement with nano-silica. The material has been collected and used as a replacement of cement because it is having Pozzolana property. The proportions of nano-silica replaced cement with 0.5% of Polycarboxylate superplasticizers are taken as 0%, 0.5% 1.0%, 1.5%, 0.20%, 2.5%, 3.0% and 3.5% and Split Tensile test result is 2.13N/mm^2, 2.84 N/mm^2 , 3.39 N/mm^2 , 4.32N/mm^2, 4.96N/mm^2, 5.15 N/mm^2, 5.77 N/mm^2 and 5.25 N/mm^2 respectively on 28th day of curing. The Split Tensile strength of concrete using nano- silica increases upto use of 3% replacement of cement. The maximum result is by replacing 3% of cement by nano-silica is 3.12N/mm^2, 3.85N/mm^2 and 5.77 N/mm^2 on 7th, 14th and 28th day of curing.



V. CONCLUSION

The objective of this study is to determine the strength of the materials by using the nano silica and also comparison with the Ordinary Portland Cement and blended cement for the cement mortar. Analyzing the results obtained from this investigation, the following conclusions are drawn.

1) From the above experiment it is observed that the Workability of concrete with use of nano-silica improve upto a limit than it decreases. The workability is in escalating order upto 2.5% of replacement of Nano-Silica with cement.
2) The Compressive Strength of partially replaced cement by nano silica concrete of grade M 20 for proportions of 0%, 0.5%, 0.10%, 1.5%, 2%, 2.5%,3% and 3.5% are 26.67MPa, 26.92MPa, 27.58MPa, 27.91MPa, 28.37MPa, 29.05MPa, 29.65 and 28.85 MPa respectively at 28th day of curing. The Compressive Strength increases upto 3% and further decreases

3) The Split Tensile strength of concrete with partially replaced cement by nano silica of grade M 20 for proportions of 0%, 0.5%, 0.10%, 1.5%, 2%, 2.5% and 3% are 2.13MPa, 2.84MPa, 3.39MPa, 4.32MPa, 4.96MPa, 5.15MPa, 5.77MPa and 5.25Mpa respectively at 28th day of curing. The Split tensile Strength increases upto 3% use of nano- silica and further decreases.
4) With the use of 3% of Nano-Silica concrete gives the maximum result in compression as 19.43MPa, 25.54MPa and 30.65MPa at 7th day, 14th day and 28th day of curing respectively.
5) With the use of 3% of nano silica gives the maximum result in Split Tensile Strength as 3.12MPa, 3.85MPa and 5.77MPa at 7th day, 14th day and 28th day of curing respectively.

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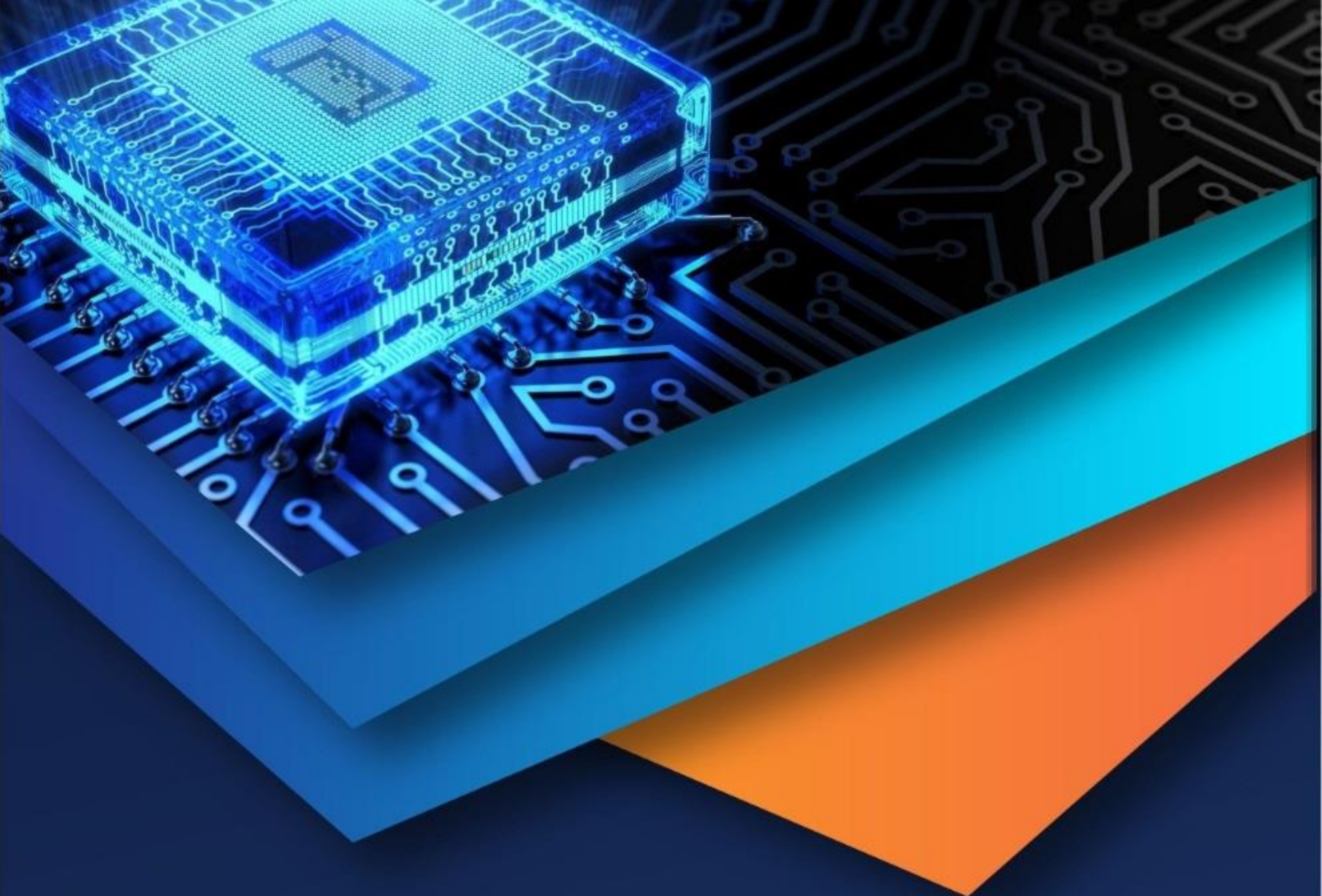

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