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EXPERIMENTAL STUDY ON COMPRESSIVE STRENGTH OF CONCRETE USING NANO SILICA

[1]Haidar Ali, Prof. [2]Monu Kumar
[1]*M.Tech Scholar, Dept. of Civil Engineering, (IIMT UNIVERSITY) Meerut , U.P., India*
[2] *Assistant Professor, Dept. of Civil Engineering, (IIMT UNIVERSITY) Meerut , U.P., India*

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.

UNIT 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.

UNIT 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 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.

UNIT III MATERIAL AND METHODOLOGY

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.

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%.

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.

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.

UNIT IV RESULT AND ANALYSIS

4.2.1. Water : In the water following testing's are perform:

(i) PH Value

(ii) Total Dissolve Solid

(i) PH Value: With the help of PH Meter we perform the testing of water to find PH-Value of water. And its results are as follows :

Table 1 : PH Value

S. No.	Sample No	PH-Value	Avg. PH-Value
1	A	7.4	7.53
2	b	7.6	
3	c	7.6	

Hence PH-Value of water used in concrete is 7.53

(ii) TDS Value: With the help of TDS Meter we perform the testing of water to find TDS-Value of water. And its results are as follows :

Table 2: TDS Value

S. No.	Sample No	TDS-Value (mg/l)	Avg. TDS-Value (mg/l)
1	A	63	65.66
2	b	64	
3	c	68	

Hence TDS-Value of water used in concrete is 65.66mg/l

4.2.2. Cement :

In the cement following testing's are perform:

(i) Initial Setting Time

(ii) Final Setting Time

(iii) Specific Gravity

(iv) fineness Of cement

(v) consistency Of cement

(i) Initial Setting Time: With the help of Vicat Apparatus we perform the testing of cement to find Initial setting time of cement. And its results are as follows :

Table 3: Initial Setting Time

S. No.	Sample No	Initial Setting Time (min.)	Avg. Initial Setting Time (min.)
1	A	33	33
2	b	34	
3	c	33	

Hence Initial Setting Time Of cement is 33 min.

(ii) Final Setting Time: With the help of Vicat Apparatus we perform the testing of cement to find Initial setting time of cement. And its results are as follows :

Table 4: Final Setting Time

S. No.	Sample No	Final Setting Time (min.)	Avg. Final Setting Time (min.)
1	A	10 Hr. 30Min	10Hr 32min.
2	B	10Hr. 32 Min	
3	C	10Hr. 32 Min.	

Hence Final Setting Time Of cement is 10 Hr.32 min.

(iii) Specific Gravity: With the help of Pychnometer Apparatus we perform the testing of cement to find Specific Gravity of cement. And it results are as follows :

Table 5: Specific Gravity Test

S. No.	Sample No	Sp. Gravity	Avg. Sp. Gravity
1	A	3.00	3.05
2	b	3.15	
3	c	3.00	

Hence Specific Gravity Of cement is 3.10

(iv) Fineness of cement: With the help of IS Sieve (90 Micron) Apparatus we perform the testing of cement to find Fineness of cement. And its results are as follows :

Table 6: Fineness Test Of cement

S. No.	Sample No	Wt Of Total cement (W1) (gram)	Wt Of cement Retain (90 Micron Sieve)	Percent age of cement Retain	Final Finenes s of cement
1	A	100	5.8 g	5.8%	5.8%
2	b	100	5.5 g	5.5%	
3	c	100	5.8 g	5.8%	

Hence Fineness of cement is 5.8%

(v) Normal consistency Result: With the help of Vicate Apparatus we perform the testing of cement to find Normal consistency of cement. And its results are as follows :

Table 7: Normal consistency Result:

S.NO.	WEIGHT OF SAMPLE TAKEN (g)	WATER ADDED In cEMENT (%)	WEIGHT OF WATER ADDED		NON PENETRATION (mm)
			IR	FR	
1	30	26	40	28	12
2	30	29	40	22	18
3	30	33	40	13	27

Hence Normal consistency Of cement is = 33%.

4.2.4. Fine Aggregate (Sand) : In Fine Aggregate following testing's are performed:

(i) Sieve analysis of sand

(ii) Specific Gravity of sand

(iii) Water absorption

(i) Sieve Analysis of Sand: With the help of IS Sieves Apparatus we perform the testing of sand to find Zone of Sand. And its results are as follows :

As per IS 383 : 1970

Table 7: Zone of sand

IS Sieve Designation	Percentage Passing For			
	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-100	90-100
600µ	15-34	35-59	60-79	80-100
300 µ	5-20	8-30	12-40	15-50
150 µ	0-10	0-10	0-10	0-15

IS Sieve Designation	Percentage Passing For	
	Sample 1	Final Zone of Sand As per IS 383
10mm	100	Zone III
4.75mm	95	
2.36mm	83	
1.18mm	78	
600µ	66	
300 µ	34	
150 µ	7	

(ii) Specific Gravity: With the help of Pychono meter Apparatus we perform the testing of sand to find Specific Gravity of sand. And its results are as follows :

S. No.	Sample No	Sp. Gravity	Avg. Sp. Gravity
1	a	2.8	2.8
2	b	2.65	
3	c	2.8	

Hence Specific Gravity Of sand is 2.8

(iii) Water Absorption : In this test we perform the testing of sand to find water absorption of sand. And its results are as follows :

S. No.	Sample No	Water Absorption	Result
1	a	1.5%	1.2%
2	b	1.2%	
3	c	1.2%	

Hence Water absorption of sand is 1.2%

4.2.5 coarse Aggregate : In coarse Aggregate following testing's are performed:

(i) Fineness Modulus

(ii) Specific Gravity

(iii) Water absorption

(iv) Impact Test

(v) crushing Value

(vi) bulk Density

(i) Fineness Modulus: In this test we perform the testing of coarse Aggregate to find Fineness modulus of coarse aggregate.

Hence the fineness modulus of coarse aggregate is = 3.3

(ii) Specific Gravity: With the help of Pychonometer Apparatus we perform the testing of coarse aggregate to find Specific Gravity of coarse aggregate. And its results are as follows :

Table 8: Specific Gravity

S. No.	Sample No	Sp. Gravity	Avg. Sp. Gravity
1	a	2.85	2.85
2	b	2.82	
3	c	2.85	

Hence Specific Gravity Of coarse aggregate is 2.85

(iii) Water Absorption : In this test we perform the testing of coarse aggregate to find water absorption of coarse aggregate. And its results are as follows :

Table 9. Water Absorption Test

S. No.	Sample No	Water Absorption	Result
1	a	0.5%	0.5%
2	b	0.8%	
3	c	0.5%	

Hence Water absorption of coarse aggregate is 0.5%

(iv) Impact Test : In this test we perform the testing of coarse aggregate to find Impact test of coarse aggregate. And its results are as follows :

Table 10: Impact Test

S. No	Wt Of Pan (W1)	Wt Of Agg. With Pan	Total Aggregate (A)	Fraction passing through 2.36mm sieve(b)	% Loss	Final Result
1	1.680	2.76	1.08	0.095	8.79	9.0
2	1.680	2.82	1.14	0.103	9.03	
3	1.680	2.79	1.11	0.102	9.18	

Hence Aggregate impact value = 9.00. since it is less than

10% then aggregate is said to be exceptionally strong.

(v) Crushing Value: In this test we perform the testing of coarse aggregate to find crushing value of coarse aggregate. And its results are as follows :

Table 11: crushing Value Test Readings

S. No.	Wt Of mould (W1) (Kg)	Weight of surface dry sample	Weight of fraction passing through 2.36mm sieve (W3)	Weight of course aggregate	Aggregate crushing value	Result
1	1.86	2.75	0.165	0.89	18.53	20.09
2	1.86	2.79	0.189	0.93	20.32	
3	1.86	2.7	0.180	0.84	21.42	

Aggregate crushing value = 20.09

(vi) Bulk Density: In this test we perform the testing of coarse aggregate to find bulk Density of coarse aggregate. And its results are as follows :

Table 12: bulk Modulus

S.No.	Volume of container (m3)	Weight of compacted aggregate (g)	bulk density of aggregate (Kg/m3)	Result (Kg/m3)
1	3 X 10-3	4760	1587	1586
2	3 X 10-3	4755	1585	
3	3 X 10-3	4762	1588	

Hence bulk density of aggregate = 1587Kg/m3

4.3 WORKABILITY TEST: SLUMP CONE TEST

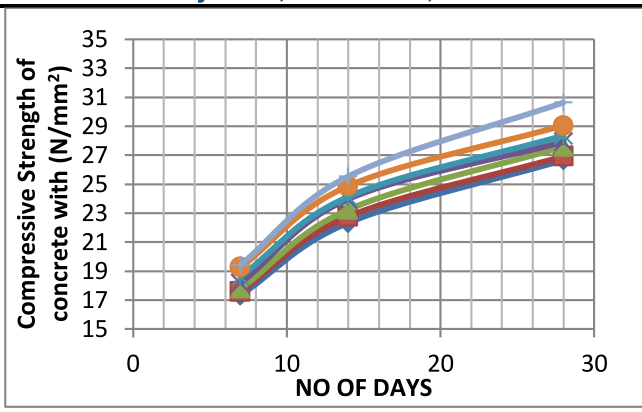
Table 13: Slump cone Test Results

Name	N	S1	S2	S3	S4	S5	S6	S7
% Nano-silica particle	0	0.5	1	1.5	2	2.5	3	3.5
Slump Value(cm)	25.43	25.9	26.5	27.36	27.95	28.43	28.72	28.24
Slump	4.57	4.1	3.5	2.64	2.05	1.57	1.28	1.73

As shown in Table 6, the Slump Value of cement replaced with nano silica concrete of 0.5% of polycarboxylate superplasticizer is 25.43cm, 25.9cm, 26.5cm, 27.36 cm, 27.95cm, 28.43, 28.72cm and 28.24cm for 0%, 0.5%, 1.0%, 1.5%, 2.0%, 2.5%, 3.0% and 3.5% respectively. The pattern of slump was one half of the cone slides down which is called shear slump. It indicates the concrete is non-cohesive and shows characteristic of segregation. The workability is increasing upto S6 and later on workability starts decreasing.

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.



UNIT 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.

- 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.
- 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
- 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.

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UNIT V BIOGRAPHIES

Haidar Ali
M.Tech Student,
Dept. Of Civil Engineering,
IIMT UNIVERSITY,Meerut, U.P., India

Prof. Monu Kumar
Assistant Professor,
Dept. Of Civil Engineering,
IIMT UNIVERSITY,Meerut, U.P., India