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ENHANCING THE PERFORMANCE OF CONCRETE BY USING NANO SILICA

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Abstract - *Nano materials have been widely used in the past few decades due to their proven capacity to enhance the mechanical properties of materials. While many studies have sought to improve the understanding of how Nano materials affect the behavior of concrete, additional research is needed in order to achieve the full potential of the material, especially in the presence of supplementary cementitious materials. This project aims to investigate the mechanical properties of cement concrete incorporating Nano-silica. It has been given that the compressive strength of mortar is increased when adding Nano silica. But in this project, we can check the performance of Nano silica when it is added to reinforced beam. It's also been said that the workability of concrete reduces when the percentage of Nano silica is more and the strength reduces at some point. So in this project the beams are casted with nominal percentage of Nano silica at which the strength increased in concrete cubes and also a conventional beam for comparison. Finally, the flexural strength of beam is found along with load vs deflection graph to show the rise and fall of strength.*

Key words: Nano silica, Compressive strength, Flexural Strength.

I. INTRODUCTION

The use of supplementary cementitious materials (SCM) reduces the embodied energy in concrete considerably. Furthermore, it significantly improves the durability of concrete and increases its lifecycle thus leading to a more sustainable design. However, despite the available literature on nanotechnology and its applications in the construction industry, further research is needed on the effect of using Nano silica (NS) in concrete, especially when combined with SCMs. Fly ash is the most commonly used supplementary cementitious material in the cement industry because of its various advantages like increased flowability, and strength gain at later ages. However, fly ash slows the setting time and the strength gain at early ages. Among all the materials Nano-silica is the most widely used material in the cement and concrete to improve the performance, because of its pozzolanic reactivity besides the pore-filling effect. The concrete strength is influenced by lots of factors like concrete ingredients, age and water cement ratio.

Researchers have examined the effects of using NS in pastes, mortars and concrete. The majority of these studies found that using small dosages of NS improves the early age and the 28-day strength, which is attributed to pore refinement and to the enhanced characteristics of the interfacial transition zone between paste and aggregate. Also, very few researchers examined the combined effect of using both NS and fly ash especially in terms of porosity and pozzolanic activity. This paper aims to investigate the effect of using NS on reinforced cement concrete's compressive strength and flexural strength.

II. SCOPE

- Further this project can be done by adding admixtures to increase the various properties of the concrete.
- The combination of the Nano materials such as Carbon Nano Fibre (CNF) and Carbon Nano Tubes (CNT) with Nano silica might improve the durability and tensile strength of the concrete.

III. LITERATURE REVIEW

Achraf Ayad, Aly Said "Using Colloaidal Nano Silica To Enhance The Performance Of Cementitous Mortar", (March 2018). Nano materials have been widely used in the past few decades due to their proven capacity to enhance the mechanical properties of materials. While many studies have sought to improve the understanding of how nanomaterials affect the behaviour of concrete, additional research is needed in order to achieve the full potential of the material, especially in the presence of supplementary cementitious materials. This study aims to investigate the mechanical properties of cement mortars incorporating both Nano-silica (NS) and class F fly ash (FA). Furthermore, mercury intrusion porosimetry (MIP) was performed to study its effect on pore characteristics, and thermo gravimetric analysis (TGA) was performed to measure the calcium hydroxide Ca(OH)2 content in the mixtures. It was found that using Nano-silica enhances the compressive strength, reduces the total porosity and accelerates the pozzolanic reaction.

Rizwan AZAM, Ahmed K. EL-SAYED, Khaled SOUDKI "Behaviour Of Reinforced Concrete Beams Without Stirrups Subjected To Steel Reinforcement Corrosion" (April 2013) .The effect of corrosion on the structural behavior of reinforced concrete (RC) beams without stirrups was experimentally investigated. A total of seven medium-scale RC beams without stirrups were constructed. The beams measured 150 mm wide, 250 mm deep and 1700 mm long. The test variables included: three different longitudinal reinforcement ratios (0.91%, 1.21%, and 1.82%) and two different corrosion levels (3% and 10%). Four beams were subjected to artificial corrosion whereas three beams acted as control un-corroded. Following the corrosion phase, all beams were tested to failure in three-point bending. Corrosion cSSrack widths and cracking patterns were recorded at different stages of corrosion. The effect of different longitudinal reinforcement ratios on the rate of corrosion was observed. Test results revealed that the beams with higher reinforcement ratios experienced slower corrosion rate compared to beams with lower reinforcement ratios. All control beams failed in shear whereas corroded beams failed in bond. There was a significant reduction in the load carrying capacity of the corroded beams without stirrups compared to the control beams.

IV. OBJECTIVES

- To increase the flexural strength of reinforced cement concrete beam by incorporating Nano silica.
- To determine the dosage of Nano silica for the beam by adding it in concrete cube at different percentage..

V. MATERIALS TO BE USED

1. Nano Silica
2. Cement
3. Aggregate
4. Water

1. NANO SILICA

Nano silica is fine material with spherical particle size is 17nm in diameter. Nano silica have the properties like compressive strength, bond strength and corrosion resistance. Nano-silica is the most widely used material in the cement and concrete to improve the performance, because of its pozzolanic reactivity besides the pore-filling effect.

Fig. 1: Nano silica

2. CEMENT

Ordinary Portland Cement of grade 53 is used for preparing concrete. And the specific gravity of OPC 53 grade of cement is 3.15.

3. AGGREGATE

Sand as fine aggregate are collected from the locally available shop. And the specific gravity of fine aggregate is 2.55. For coarse aggregate, the particle size of 20mm is collected and the specific gravity of the coarse aggregate is 2.81.

4. WATER

Tap water was used in this experiment. The properties are assumed to be same as that of normal water. Specific gravity is taken as 1.00.

VI. CASTING AND CURING

1. CUBE

The standard size of cube for compression test is 150mm × 150mm × 150mm.

Table 1: Quantity of materials for cube

SI.NO	% of Nano silica	Nano silica (kg)	F.A (kg)	C.A (kg)	Cement (kg)
1	0%	-	2.39	4.05	1.64
2	1%	0.0164	2.39	4.05	1.6236
3	1.5%	0.0246	2.39	4.05	1.6154
4	2%	0.0328	2.39	4.05	1.6072
5	2.5%	0.041s	2.39	4.05	1.5999

2. BEAM

The size of the beam is 100mm×150mm×1200mm. From the results of compression test the higher compressive strength of the cube is taken for the beam casting. The 1.5% and 2% of Nano silica have the higher compressive strength in cube. So the above two percentage is taken for casting the beam.

The RCC beam is casted into two types:

- With stirrups
- Rebar only at tension zone

2.1 BEAM WITH STIRRUPS

In this type of beam, the reinforcement bar of 12mm dia with stirrups of 8mm diameter at the spacing of 100mm c/c placed at 20mm clear cover. After that the concrete is prepared and poured into 3 layers. The concrete is compacted evenly throughout the beam by using the tamping rod. The top of the beam is properly leveled by using trowel. The beam is removed from the mould after 24 hours and the curing is done for 28 days.

2.1 BEAM WITH REBAR ONLY AT TENSION ZONE

In this type of beam, the reinforcement bar of 12mm dia placed at tension zone with clear cover of 20mm. the casting of the beam is similar to the procedure of with stirrups.

Table 2: Quantity of materials for beam

SINO.	% of Nano silica	Nano silica (kg)	F.A. (kg)	C.A. (kg)	Cement (kg)
1	0	-	12.78	21.63	8.76
2	1.5%	0.1314	12.78	21.63	8.6286
3	2%	0.1752	12.78	21.63	8.5848

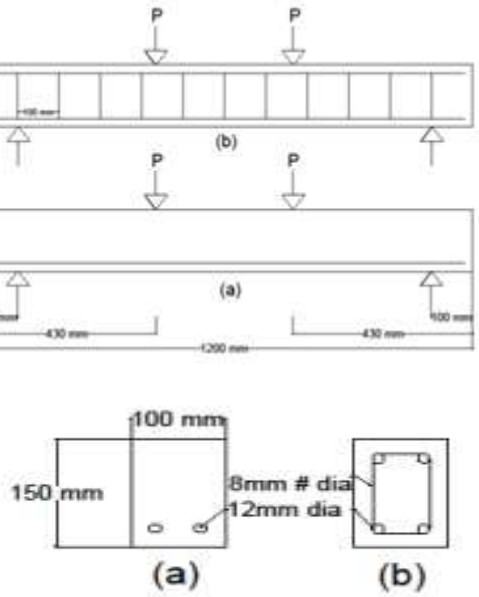

Fig. Beam reinforcement

3. CURING

The test specimen is stored in a place, free from vibration, in moist air of at least 90 percent relative humidity and at a temperature of 27° ± 2°e for 24 hours ± l hour from the time of addition of water to the dry ingredients, After this period, the specimens is marked and removed from the moulds and, unless required for test within 24 hours, immediately submerged in clean fresh water and kept there until taken out just prior to test. The water in which

the specimens are submerged are renewed every seven days and are maintained at a temperature of 27° ± 2°C. The specimens are not allowed to become dry at any time until they have been tested.

VII. TEST TO BE PERFORMED

1. SPECIFIC GRAVITY TEST

The physical properties and of coarse aggregate and fine aggregate

Table 3: Property of coarse aggregate and fine aggregate

Property	C.A.	F.A.
Specific Gravity	2.81	2.55
Bulk Density(kg/L)	1.408	-
Loose Bulk Density	1.25	-
Water Absorption	4.469	0.0651
Impact Value	26.910	-
Crushing Value	26.514	-
Fineness Modulus	3.38	2.84

2. SLUMP CONE TEST

The slump cone test is determined for the grade of M30 and Nano silica incorporated with concrete. The dosage of Nano silica for slump cone test is 1%, 1.5%, 2%, 2.5%. For conventional concrete, the slump value is 75 mm and for Nano silica incorporated concrete the slump value is 0 mm. the latter has 0 mm slump because of low workability. The density of Nano silica is very less and the water consumption is very high. So the workability is reduced and slump value is nil.

3. COMPRESSION TEST (CUBE)

The compressive strength of the cube is determined after 28 days. 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.

Table 4: Compressive strength for cube

% of Nano Silica	Comp. Strength ($\frac{N}{mm^2}$)	Comp. Strength ($\frac{N}{mm^2}$)	Comp. Strength ($\frac{N}{mm^2}$)	Mean comp. Strength($\frac{N}{mm^2}$)
0%	31.6	32.17	30.7	31.49
1%	32.8	33.04	32.48	32.77
1.5%	36.08	37.64	36.6	37.64
2%	38.71	38.62	37.9	38.62
2.5%	39.37	38.88	39.8	38.88

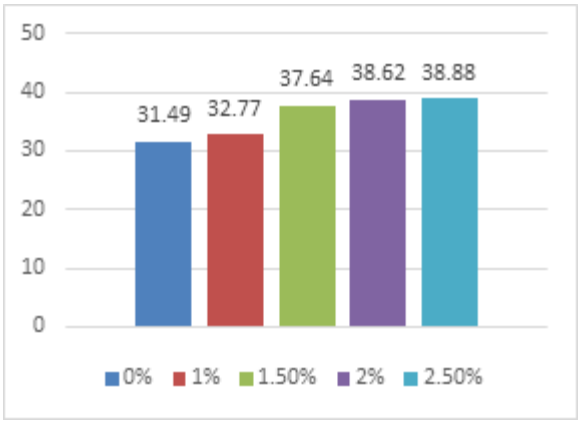

Chart 1: Mean compressive strength

4. FLEXURAL TEST

Flexural test is conducted on the reinforced concrete beam with dimension of 100mm × 150mm for a length of 1.2m. The beam is subjected to two point loading.

Table 4: Flexural Test result

% of Nano silica	With stirrups		Rebar only at tension zone	
	Ulti. load (kN)	Flex. Stren ($\frac{N}{mm^2}$)	Ultimate load(kN)	Flexural strength ($\frac{N}{mm^2}$)
0%	10.30	4.57	21.58	9.59
1.5%	39.53	17.57	47.48	21.10
2%	23.54	10.46	33.84	15.04

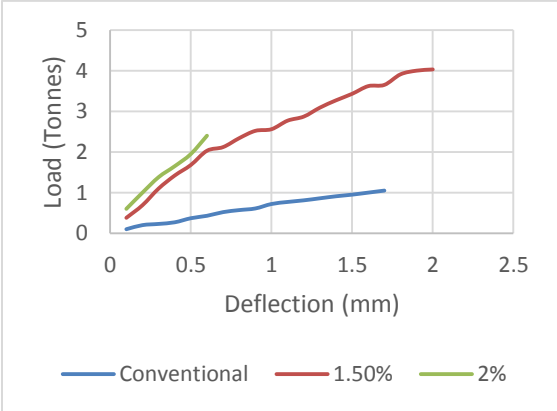

Chart 2: Load vs Deflection for With stirrups

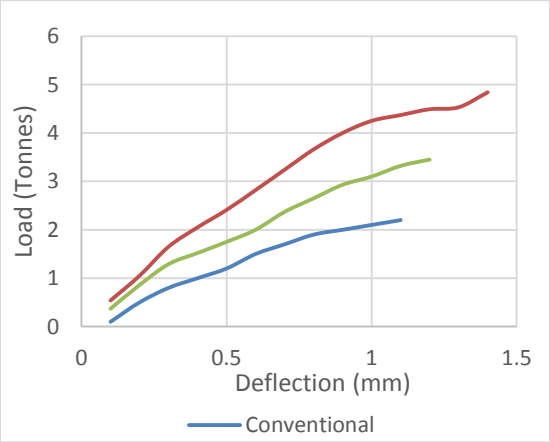

Chart 3: Load vs Deflection for Rebar at Tension zone

VIII. CONCLUSION

Based on the above experimental procedure and test, we conclude as;

1. The use of Nano silica can increase the strength of concrete not only in compression test but also in flexural test.
2. The compression strength of Nano silica incorporated concrete is 1.5% more than conventional concrete as well as the flexural strength is 1.5% more than conventional conc
3. The use of Nano silica incorporated concrete can be more economical in
4. terms of strength when compared to other type of concrete.
5. In this project, we also saw that the water absorbing capacity of concrete with Nano silica is lesser than conventional concrete.
6. We strongly recommend 1.5% dosage of Nano silica in reinforced structure because it can withstand high load along with deflection and has better workability when compared to other ratios.

REFERENCES

[1] Mohameed BS, Awang AB, WongSS,Nhavene CP (2016) Properties of Nano silica modified rubbercrete . Journal of Cleaner Production 119; 66-75.
[2] Hae Jun Yang, June Su Kim, Sung Ho Kim and Hyun Do Yun (2005) Flexural performance of reinforced concrete beam with layer of expansive strain hardening cement.
[3] Achraf Ayad, Aly Said (2018) using colloidal Nano silica to enhance the performance of cementitious mortars.
[4] Qing Y., Zenan Z., Deyu K. and Rongshen C. (2007) Influence of Nano Silica Addition on Properties of Hardened Concrete Paste as compared to Silica Fume.
[5] Rizwan AZAM, c, Ahmed K. EL-SAYED, Khaled SOUDKI. (2013) Behavior of reinforced concrete beams without stirrups subjected to steel reinforcement corrosion.
[6] IS 516 (1959): Method of Tests for Strength of Concrete [CED 2: Cement and Concrete]
[7] IS 2386-3 (1963): Methods of test for aggregates for concrete, Part 3: Specific gravity, density, voids, absorption and bulking [CED 2: Cement and Concrete]