Experimental Analysis of Durability of Concrete With The Use of Nano Silica

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Abstract- *concrete is the most common used material for construction and their design consumes almost the total cement production in the world. The use of large quantities of cement produces increasing of CO2 discharge and as significance the greenhouse effect. A method to reduce the cement content in concrete mixes is the use of silica fines. One of the silica fines with high potential as cement replacement and as concrete additive is Nano-silica (nS).*

Keywords- Nano Concrete, Nano Silica,

I. INTRODUCTION

Nanotechnology has changed our image, expectations and capabilities to switch the material world, the expansions in Nano-science will have a great influence on the field of construction materials. Better understanding and engineering of complex structure of cement based materials at Nano-level will definitely result in a new generation of concrete, stronger and more durable, with desired stress-strain behaviour. This research work addresses the measures taken to prevent or minimize the deterioration of concrete, which confronts the Durability aspect of Concrete.

Durability of Concrete depends on its resistance to deterioration and the environment in which it is placed. Concrete can be made acid resistant using classical as well as novel techniques like nanotechnology.

II. LITERATURE REVIEW

Mr M L Ranjith Kumar, Q Roger, P Santhosh, K Gowtham, E D Jothi Rajan (2016) stated that 2.5% of nano silica have been added to concrete mixture by replacing some amount of cement. Also the Plaster of paris is used to increase the workability. M25 grade of concrete have been used.
Based on the test results, the author concluded that the partial replacement of 2.5% cement by nano silica and addition of plaster of paris increases the durability of concrete i.e. investigated by Water Absorption Test, Sorptivity Test and Acid Attack Test.

Kavitha S., A Sandhiyadevi (2016) examined that performance of the nano silica concrete with and without flyash was studied and compared to performance of control mix. Fresh properties of concrete determined by carrying out workability test, compacting factor test and flow test.

The mechanical properties are determined by Compressive Strength, Split Tensile Strength, Modulus of Elasticity, Flexural Strength and Impact Resistance. The durability properties are determined by acid attack test, bulk diffusion test.The author reported that the strength properties increased upto 3% partial replacement of Cement by nano silica and partial replaced cement using Flyash

Hongjian Dua, Suhuan Du, Xuemei Liu (2012) studied The literature review about nanoparticles contribution for HPC shows that: Nanoparticles allows for a dramatic increase in the mechanical strength of cementitious composites. The mechanisms are as follows:

1. They can fill the voids left by C-H (Calcium Hydroxides) structure leading to a denser concrete.
2. They react with Ca(OH)2 crystals producing C–S–H gel. Besides the nano-particles act as kernels in the cement paste which makes the size of Ca(OH)2 crystal smaller.

Nano-silica seems to be able to control calcium leaching. Colloidal dispersions were much more effective reducing the effects of the degradation than the dry ones.

F. Pacheco Torgal, S. Miraldo Y. Dingb,J.A. Labrincha (2014)

The study was done using 0.3% and 0.9% of nano silica and following conlcusion drawn.

1) In comparison with the reference concrete, the study showed that nano-silica exhibited obvious pozzolanic reaction with the Portlandite, even at a very early stage. This was verified by the reduced Portlandite content and the increased compressive strength at 1 day.
2) In addition, MIP results revealed that the pore size distribution became refined which reduced the ingress rate of water and chloride ions.
3) Increases the compressive strength and resistance against water and chloride ions penentration for concrete added with nano-silica, even at a small amount of 0.3%.

Jonathan S. Belkowitz and Dr Daniel Armentrout (2010) From the experiments performed, it was validated that as the silica decreases in size and increases in size distribution, a number of properties begin to improve. When the silica diameter increases, the rate of early pozzolanic reaction decreases. The nano silica was more effective, due to exposed surface area, in reacting pozzolanically. The micron silica would only react as silica became available. As the CH reacts with exposed micro silica, more silica will become exposed and ready to pozzolanically react. If allowed to cure for an extended period of time the unhydrated silica will eventually pozzolanically react with the CH in solution, reducing CH concentration, increasing the concentration of the CSH structure and thereby increasing compressive strength.

III. METHODOLOGY

Test Done on Ingredients

1) Natural Coarse Aggregates
- Abrasion Value
- Impact Value
- Crushing Value
- Water Absorption
- Specific Gravity
- Fineness Modulus

2) Sand
- Water absorption
- Specific Gravity
- Silt Content
- Fineness Modulus

3) Cement
- Fineness Test
- Standard Consistency test
- Initial And Final Setting Time
- Compressive Strength Test

4) Durability Test
- Acid Attack
- Sulphate Attack

IV. PROPERTIES OF MATERIAL

1) Cement

Physical properties of cement

Table 1.

Sr. No.	Test	Result
1	Consistency	31.00%
2	Initial setting time	120
3	Final setting time	225
4	Soundness	1.49
5	Compressive strength after 3-days	29.89
6	Compressive strength after 7-days	39.12
7	Compressive strength after 28-days	55.10

2) Coarse Aggregates

Physical Properties of Coarse Aggregate

Table 2.

Sr. No.	Properties	20mm DN	10mm DN
1	Impact value	10.12	-
2	Crushing value	11.24	14.15
3	Specific gravity	2.87	2.85
4	Water absorption	0.7	0.9
6	Flakiness Index	13.05	10.23
7	Elongation Index	12.91	9.55

3) Fine Aggregates

Physical Properties of Fine Aggregate

Table 3.

Sr. No.	Properties	Values
1	Fineness Modulus	2.58
2	Water absorption	1.23
3	Specific Gravity	2.65
4	Silt Content	0.60
5	Density (gm/cc)	1.59

4) Properties of Nano Silica

Table 4.

Sr. No.	Test Item	Test Results
1	Particle Size	17 N.m.
2	Specific Surface Area (M2/G)	202
3	PH Value	4.12
4	Loss on Draying @ 150 DEC.C	0.47
5	Loss on Ignition @ 1000 DEC.C	0.66
6	Sieve Residue (5)	0.02
7	Tamped Density g/L	44
8	Sio2 Content (%)	99.88
9	Carbon Content (%)	0.06

10	Chloride Content (%)	0.009
11	Al2o3	0.005
12	Tio2	0.004
13	Fe2o3	0.001

V. CASTING SCHEDULE

Mix Design

Table 5.

Proportion		Weight (kg.)
Water		177.4
Cement		394.3
Aggregate	Sand	757.5
	20 mm	580.9
	10 mm	576.8

Variation of Nano Silica

Table 6.

MIX NO.	% OF Ns	CUBE NO	BEAM NO
1	0.00%	30	30
2	0.50%	30	30
3	1.00%	30	30
4	1.50%	30	30
5	2.00%	30	30

VI. RESULTS

1. Compressive strength results

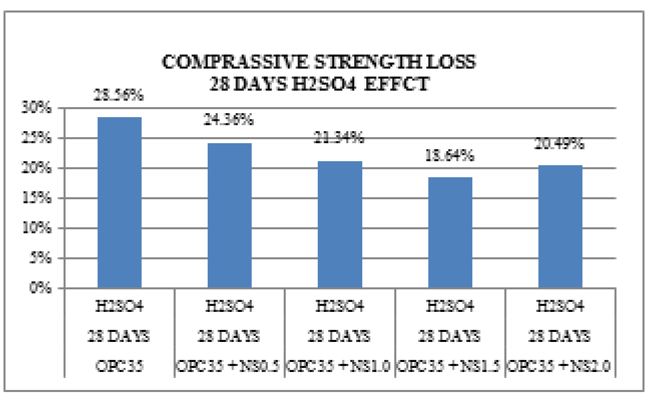


Figure 1.

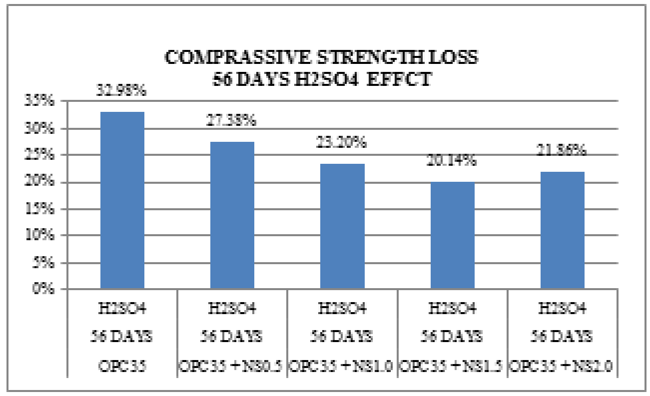
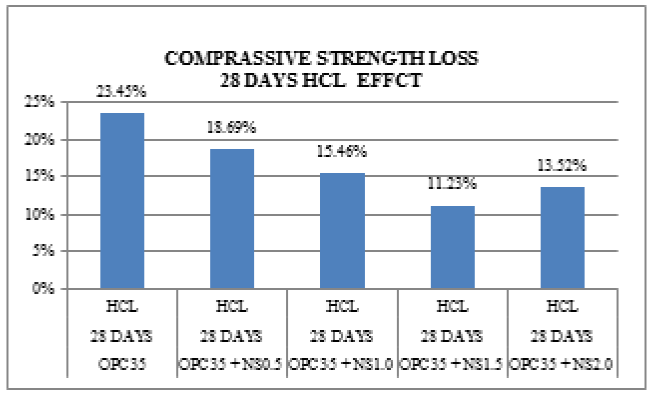


Figure 2.



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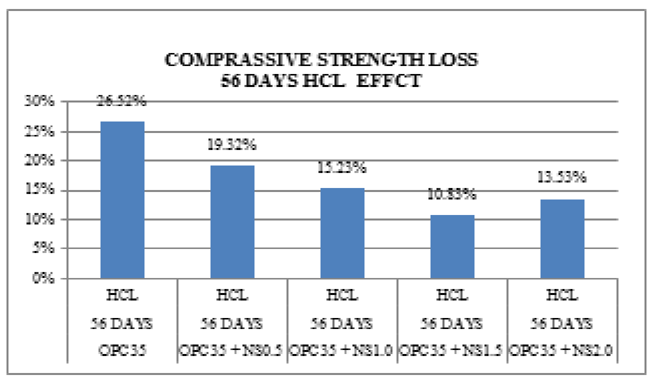
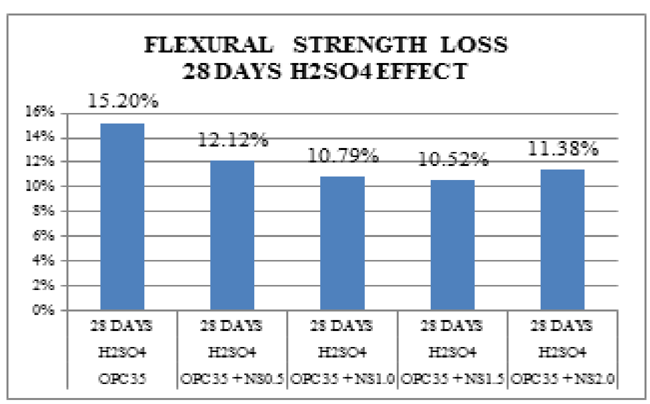


Figure 4.

2. Flexural Strength



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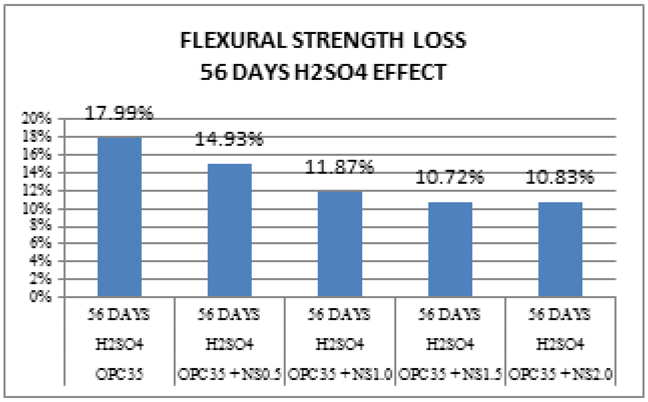

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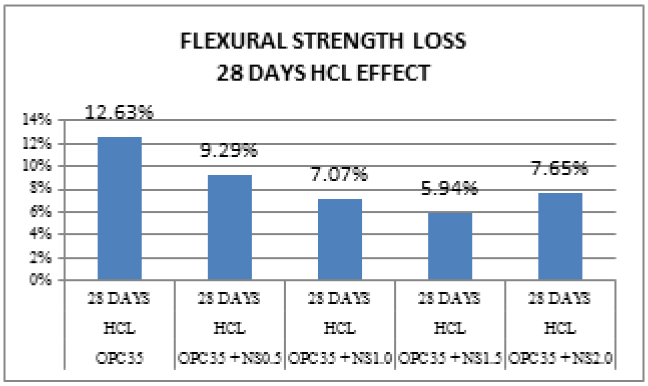

Figure 7.

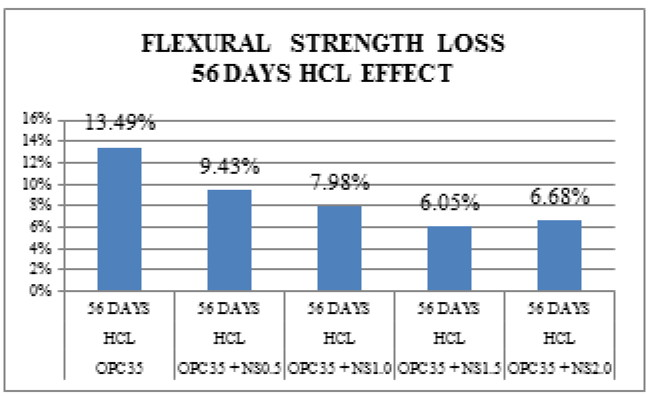

Figure 8

VII. CONCLUSION

- Strength Properties of the normal concrete increase up to 1.5 % partially replacement of Cement with nano silica.
- Minimum Strength loss observed at 1.5% partially replaced cement concrete with nano silica.
- Minimum Weight loss observed at 1.5% partially replaced cement concrete with nano silica when kept in acidic and chloride environment.
- At 1.5% Partially replaced cement concrete with nano silica resistance to acidic and chloride environment is more

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