International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 10 | Oct 2020 www.irjet.net p-ISSN: 2395-0072

An Investigation of Performance of Nano Concrete

Siddarth M S[1], P S Tejaswini[2]

[1]Student, Dept. of Civil Engineering, Dayananda Sagar College of Engineering, Bengaluru-560078
[2]Assistant Professor, Dept. of Civil Engineering, Dayananda Sagar College of Engineering, Bengaluru-560078

Abstract - *Concrete is considered as brittle materials and widely used due to high compressive strength but unfortunately having and has low tensile strength that has a numerous negative impacts on the lifespan of concrete made structures. Therefore, mechanical properties of cement have been investigated experimentally using different types and ratios of Nano material to improve the properties by incorporating Nano particles such as Nano-Silica and Nano-Alumina as admixtures. The present work includes Nano-Silica and Nano-Alumina as admixtures in cement, with 0.5%, 1%, and 1.5% doses as partial replacement of cement by weight. The parameters that are taken consideration during the investigation were Cement, Fine aggregate, Coarse aggregate, Nano-Silica, Nano-Alumina, super- plasticizers and Water. Initial test's as been carried out for the cement, like initial setting time and final setting time, For the fresh concrete Slump cone test as been carried out , Whereas, for the harden concrete, Compressive strength, Split tensile and Flexural strength tests carried out respectively to find the strength of the concrete by replacing Nano-Silica and Nano-Alumina separately.*

1. INTRODUCTION

Concrete is considered as brittle materials and widely used due to high compressive strength but unfortunately having and has low tensile strength that has a numerous negative impacts on the lifespan of concrete made structures. Therefore, mechanical properties of cement have been investigated experimentally using different types and ratios of Nano material to improve the properties by incorporating Nano particles such as Nano-Silica and Nano-Alumina as admixtures. The present work includes Nano-Silica and Nano-Alumina as admixtures in cement, with 0.5%, 1%, and 1.5% doses as partial replacement of cement by weight. The parameters that are taken consideration during the investigation were Cement, Fine aggregate, Coarse aggregate, Nano-Silica, Nano-Alumina, super- plasticizers and Water. Initial test's as been carried out for the cement, like initial setting time and final setting time, For the fresh concrete Slump cone test as been carried out , Whereas, for the harden concrete, Compressive strength, Split tensile and Flexural strength tests carried out respectively to find the strength of the concrete by replacing Nano-Silica and Nano-Alumina separately.

1.1 The History of Nanoparticles and Research Objectives:

Nanomaterials have a particle size of less than 100 nanometers (nm). For concrete technology, most nanomaterials used in concrete are less than 200nm. The ultrafine nanomaterial helps reduce cement requirement and improve the binding effect. Nanomaterials lessen the micropores and become filler agents thus yielding a denser concrete. As fillers, the nanomaterials reduce the growth of micropores in the ultra-high performance concrete (UHPC) structures. Nanoparticles can be the bridge between bulky and large ingredients (aggregate and sand) and the new molecules developed during the hydration process. Nanoparticles have quantum effects based on the close association with their electrons caused by the small size. The quantum effect harnesses the binding impact with other materials in bulk. The physical properties of the material at the nanoscale are unique compared to the materials in the bulk scale. For metals and their oxides, the nanoparticles exhibit significant change; although the change is not always favourable.

2. Aims and Objectives

This study contains various objectives and they are as follows:

- To conduct tests on cement in order to determine its material properties due to partial replacement with Nano materials.

- To study the effect of various dosages of Nano silica and Nano alumina have on the compressive strength of concrete.

- To study the effect of various dosages of Nano silica and Nano alumina have on the split tensile strength of concrete.

- To analyze the material composition of Nano concrete by Scanning Electron Microscopy (SEM) method and verify with those developed by the other researchers and codal provisions

2.1 Scope and Significance

Nanotechnology is infiltrating the Civil Engineering sector as a new industrial revolution and has Provided a new impetus for the development of high-performance and smart or multifunctional concrete. High performance, durable and environmentally friendly concrete can be created by restructuring or altercating nano materials and structural units by interpreting material genetic code and drawing up a blueprint. By utilization of nanotechnology, it is possible to promote the understanding and knowledge of concrete behaviour, one can control and improve concrete efficiency as well as lower concrete production and environmental cost as it can lengthen the service life of engineering

infrastructures and reduce the relative demand of concrete. It is utterly important to guide the sustainable production and application of concrete materials. Ultra-high strength concrete, photo catalytic concrete, self-heating concrete, bendable concrete and concrete containing CNTs are few among the many important and necessary developments that have been made in the field of nano concrete. The application of nanotechnology is being extended to the every nook and corner of civil engineering sector, but a lot of awareness and research should be carried out to completely exploit its benefits. New properties and excellent functionality to concrete can be added with the help of nanotechnology. The materials made of nanotechnology also enhance the life span of the structures to longer periods.

Table 1: Test Results on Ordinary Portland cement

Sl no	Test Parameters	Results	Permissible Limits	IS Codes
1	Initial setting and Final setting Time	33&320min	30 minutes (minimum) & 600 minutes (maximum	IS:4031(Part -5) - 1988
2	Specific gravity	2.99	-	-
3	Compressive strength			IS:4031(Part -6) - 1988
	7 days	-	37	IS : 2720-Part 3
	28 days	-	53	

Characteristics of fine aggregate		
SL.NO	Description	Value
1	Specific gravity	2.55
2	Water absorption	2.99%
3	Moisture content	1.99%
4	Grading	ZONE II

Characteristics of coarse aggregate		
SL.NO	Description	standards
1	Specific gravity	2.73
2	Water immersion	0.20%
3	Shape	Angular
4	Dampness content	Nil

Table 2 : Nano-Silica

Characteristics	Values
Specific Surface Area (m2/g)	202
pH value	4.11
Loss on drying (%)	0.46
Loss on ignition(%)	0.65
Sieve Residue	0.03
Density (g/cm3)	2.39
SiO2 Content (%)	99.89
Carbon content (%)	0.07
Chloride content (%)	0.008
Al2O3 (%)	0.006
TiO2 (%)	0.005
Fe2O3 (%)	0.002
Specific Gravity	2.19
Particle Size (nm)	16

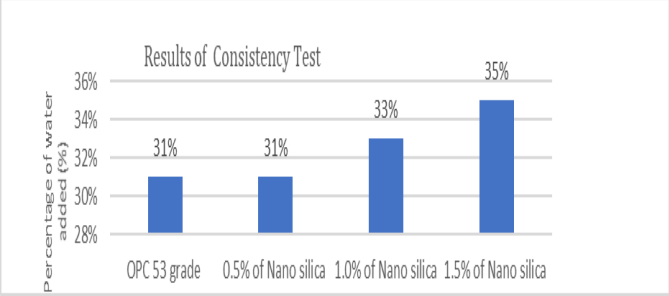
Table3 : Nano-Alumina

Characteristics	values
Specific surface area(m^2/g)	180
pH value	6
Loss on drying (wt %)	<3
Loss on ignition (wt %)	<5
Sieve residue	<0.06
Density (g/cm^3)	3.98
Si content (ppm)	≤15
Na content (ppm)	≤34
K content(ppm)	≤30
Ca content(ppm)	≤1
Mn content(ppm)	≤1.4
Fe content(ppm)	≤15
Specific gravity	3.8
Particle size(nm)	20

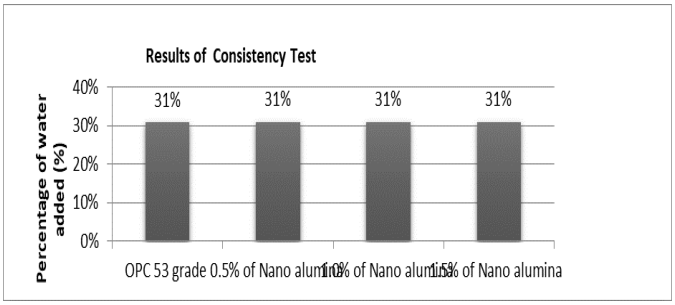
3. CONCLUSIONS

Consistency Test

The following graph depicts the results of consistency test carried out on OPC 53 grade cement and Nano-Silica replaced cement

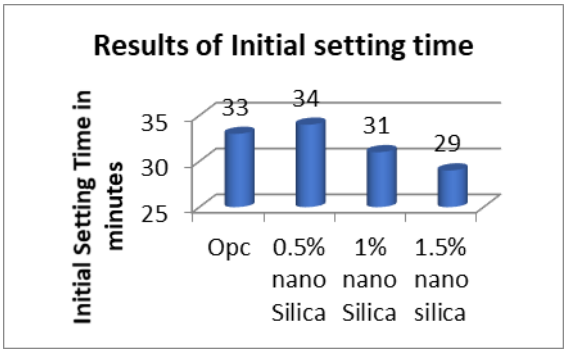


The following graph depicts the results of consistency test carried out on OPC 53 grade cement and Nano-Alumina replaced cement

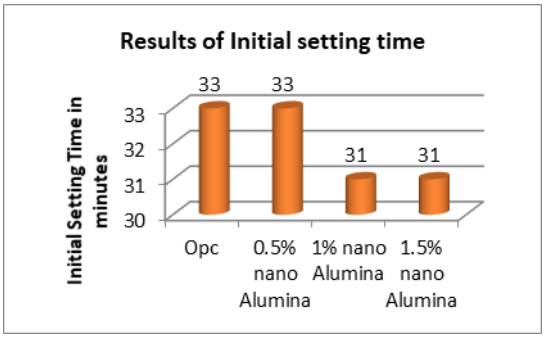


Initial Setting Time Test

The following graph depicts the results of initial setting time test carried out on OPC 53 grade cement and Nano-Silica replaced cement

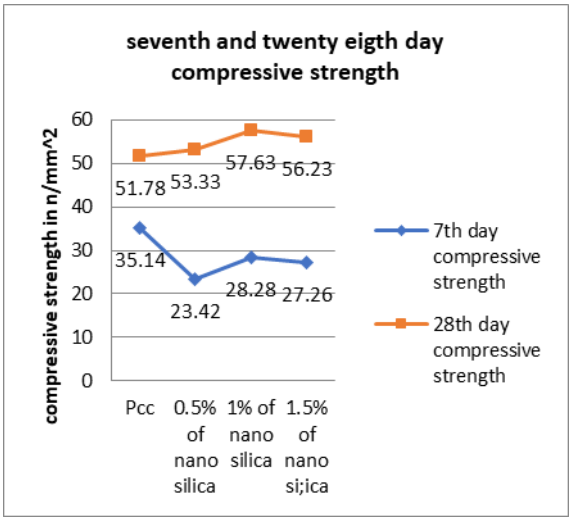


The following graph depicts the results of initial setting time test carried out on OPC 53 grade cement and Nano-Alumina replaced cement

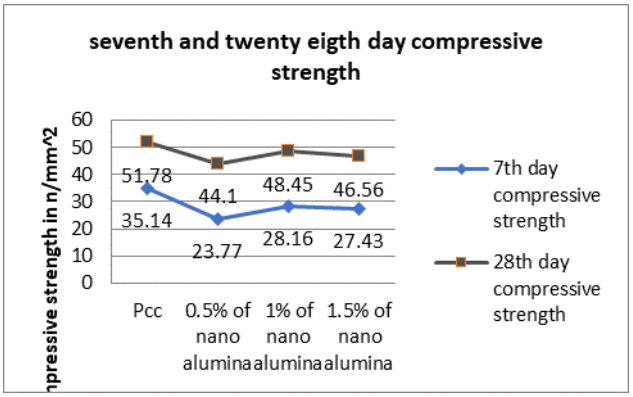


Compressive Strength Test

The following line graph displays the seventh and twenty eigth day compressive strength test results of PCC and Nano-Silica concrete

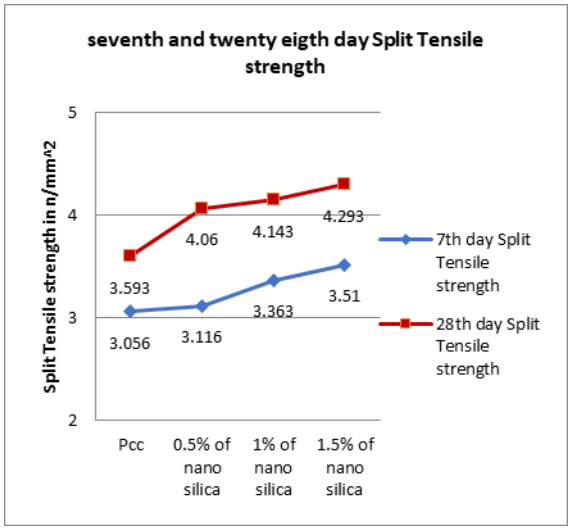


The following line graph displays the seventh and twenty eigth day compressive strength test results of PCC and Nano-Alumina concrete.

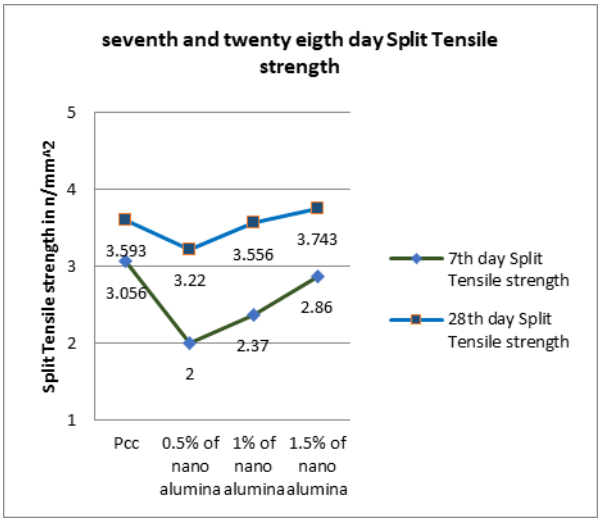


Split Tensile Strength Test

The following bar chart displays the seventh and twenty eigth day split tensile test results of PCC and Nano-Silica concrete.



The following bar chart displays the seventh and twenty eigth day split tensile test results of PCC and Nano-Alumina concrete



This chapter presents the conclusions reached in experimental work to appreciate the behaviour of Nano-Silica and Nano-Alumina in concrete. M40 mark of concrete was produced with a water-cement ratio of 0.5. The study is limited to appreciate the behaviour of Nano-Silica and Nano-Alumina when added as mineral admixtures to concrete.

1. The results obtained by experimental work are comparable with the results obtained by various research journals and hence the results can be conveniently used.

2. Establishment of standard mix design procedure and appropriate testing methods

Obtained by various research journals and hence the results can be conveniently used.

2. Establishment of standard mix design procedure and appropriate testing methods are essential for wide spread use of Nano-Concrete.

3. Comparison between Nano-Silica concrete and PCC has revealed that the maximum compressive strength of Nano-Silica concrete at 1% addition of Nano-Silica on both seventh and twenty eigth day the compressive strength were 56.6N/mm^2 and 28.28N/mm^2 respectively and it was maximum at 1% replacement of Nano silica .

4. The replacement of Nano-Alumina at 1% of compressive strength were compared to PCC. It was maximum at 1% At both seventh and twenty eigth day maximum a 28.16N/mm^2 and 48.45 N/mm ^{2}respectively.

5. Comparison between Nano-Silica concrete and PCC has revealed that the maximum split tensile strength of Nano-Silica concrete is at 1.5% addition of Nano-Silica was maximum .The split tensile strength on seventh and twenty eigth day were 3.51N/mm^2 and 4.293N/mm^2 respectively .

REFERENCES

[1]. Nano Alumina Based High Strength Concrete by, Ibadur Rahman, Nirendra Dev , (International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-9 Issue-4, February 2020

[2]. Repercussion of Nano silica on M40 Grade Concrete by, Darshan A Patel, C. B. Mishra (International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653, Volume 5 Issue IV, April 2017).

[3]. Effect of nano-alumina on workability, compressive strength and residual strength at elevated temperature of Cement Mortar by Raje Gowda, H Narendra , (INTERNATIONAL CONFERENCE ON NANOTECHNOLOGY (ICNANO-2016))

[4]. Experimental investigation into the compressive strength development of cemented paste backfill containing Nano-silica by Babak Koohestani, Tikou Belem, Ahmed Koubaa (Published by Elsevier Ltd, 22 June 2016)

[5]. Physico-mechanical, microstructure characteristics and fire resistance of cement pastes containing Al2O3 nano-particles by Mohamed Heikal, M.N. Ismail c , N.S. Ibrahim (Published by Elsevier Ltd, 18 May 2015) [6]. Influence of nano materials on flexural behaviour and compressive strength of concrete by Anwar M. Mohamed (published on HBRC Journal , 11 November 2014), [7-]. The effects of nano-silica and nano-alumina on frost resistance of normal concrete by Kiachehr Behfarnia, Niloofar Salemi (Published by Elsevier Ltd, 20 July 2013),

[8]. Characterization of high strength mortars with nano alumina at elevated temperatures by Nima Farzadnia , Abang Abdullah Abang Ali (Published by Elsevier Ltd, 8 August 2013

[9]. Al2O3 nano particles in concrete and different curing media by Nazari and Riahi (doi:10.1016/j.enbuild.2011.02.018, Published by Elsevier Ltd, 27 February 2011)

[10]. Investigations on the Development of Powder Concrete with Nano-SiO2 Particles by Byung Wan Jo, Chang Hyun Kim, and Jae Hoon Lim (KSCE Journal of Civil Engineering Vol. 11, No. 1 / January 2007),