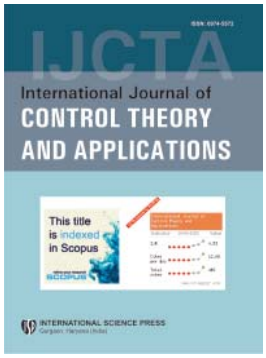

International Journal of Control Theory and Applications

ISSN : 0974–5572

Volume 10 • Number 27 • 2017

Experimental Study the Compressive Strength of Concrete By using Nano Silica Addition and Replacement of Cement

R. Roselin[a] and M.S. Ravi kumar[b]

[a]*R.Roselin, Research scholar at NIU Kumaracoil, kanyakumari District, Tamil Nadu*

[b]*Dr. M.S. RaviKumar, Principal, PSN college of Engineering and Technology, Thirunelveli, Tamil Nadu state, India*

E-mail: roselinkalist12@gmail.com

Abstract: Nano silica is most common Nano additive to concrete. It is reported that nano silica was found to be much effective than micron sized silica for improving the performance such as permeability, and subsequently, durability. Is the first Nano product that replaced the micro silica, Advancement made by the study of concrete at Nano scale have proved Nano silica much better than silica used in conventional concrete. It provides High compressive strength concrete.In this experimental investigation, study the strength of concrete containing nano silica with the cement by using addition and replacement of various percentages. There are five different addition and replacement percentages of nano silica (0%, 1%, 2%, 3%, 4%) is used in this study. The hardened concrete tested on compressive strength and tensile strength measured by 7days, 14 days and 28 days.

Keywords : *Nano silica, Compressive Strength.*

1. INTRODUCTION

Nanotechnology is an emerging field of science related to the understanding and control of matter at the Nano scale, *i.e.*, at dimensions between approximately 1 and 100 nm. At the Nano scale, unique phenomena enable novel applications. Nanotechnology encompasses Nano scale science, engineering, and technology that involve imaging, measuring, modelling, and manipulating matter at this length scale. “Nano” means 1-billionth or 10^{-9}. Therefore 1 nm is 1-billionth of a meter. Nano silica is most common Nano additive to concrete. It is reported that nano silica was found to be much effective than micron sized silica for improving the performance such as permeability, and subsequently, durability.

Concrete is the most widely used construction materials in the world due to its low cost and good durability. Ordinary Portland Cement (OPC) is the main ingredient of concrete. However, the use of cement in concrete has raised concern of its sustainability, given the fact that the production of one tonne of OPC releases approximately one tonne of carbon dioxide to the atmosphere. Due to increase in population and urbanisation the increasing use of concrete is unavoidable in near future. This concern has led the use of supplementary cementitious materials (SCMs) as partial replacement of large amount of OPC in the concrete. Fly ash is one of the SCMs that is widely used a partial replacement of OPC in the concrete. Nano-silica (NS) has recently been introduced as an advanced pozzolan to improve the microstructure and stability of cement based system [1].

It has been observed that the NS consumed free lime (calcium hydroxide) during cement hydration and formed calcium silicate hydrate (CSH) gel due to its high fineness and reactivity [2]. In addition, the NS is particularly beneficial in acting as a nucleus to make the cement hydrate dense and improves the interfacial transition zone despite of small amount of replacement. From some conducted experiments, Zhang and Islam [3] and Jo et al.

Among all the available nano-materials for application in cement and concrete, silica nano-particles preferably called Nano-Silica (NS) was found to be reasonably proficient in achieving significant improvements in the mechanical and micro-structural characteristics of paste and Mortar [4].

2. MATERIALS AND METHODS

2.1. Cement

An Ordinary Portland Cement (OPC) 43 grade confined to the Indian standards (IS 8112:1989) was used in this experimental investigation.

Figure 1: OPC 43 grade CEMENT

2.2. Fine aggregate

The natural river sand available to the zone II of IS 383:1970. Fine aggregates as sand is sieved through 4.75mm sieve and used for the mix. fine aggregates were not constant in the mix for a good concrete mix fine aggregates are need to be clean, hard strong free of absorbed chemicals. For increased workability and for economy as reflected by use of cement, fine aggregate should have a round shape. The purpose of fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent.

Figure 2: Coarse Aggregate

2.3. Coarse aggregate

In locally available quarry crusted aggregate was used in this experimental study. It gives body to the concrete, reduces shrinkage and effect economy, the aggregate occupy 70%-80% of volume of concrete The size of coarse aggregate was less than 40 mm as per IS 383:1970.

Figure 3: Coarse Aggregate

2.4. Nano silica

Nano silica is the first nano product that replaced the micro silica. The uses of nano silica makes concrete financially mine attractive and reduces CO_2 foot print of the produced concrete product.

Figure 4: Nano Silica

Table 1
Properties of nano silica

Test Item	*Test Results*
P_H Value	4.12
Sieve Residue	0.02
SiO_2 Content (%)	99.88
Carbon Content (%)	0.06
Chloride Content (%)	0.009
Al_2O3	0.005
TiO_2	0.004
Fe_2O_3	0.001

2.5. Super plasticizer

The super plasticizer or water reduces are used to increase the workability of freshly mixed concrete. The main principle mode of action of super plasticizer in their ability to disperse cement particles very efficiently.

2.6. Water

Portable water confirming to IS 456-2000 was used for casting and curing the PH value of water is 7.

2.7. Mix design

Mix design is done as per IS 10262-2009 for a target strength of 25 MPa. The mix proportion 1:1.25:273 and the water cement ratio is 0.45. The various ingredients used in the mixes are as per Table 2.

Table 2
Mix Proportion

Ingredients	*Cement*	*Fine aggregate*	*Coare aggregate*	*Water*
Quantity kg/m^3	425.7	516.499	1073.956	18.6
Ratio	1	1.213	2.5	0.45

2.6. Preparation of specimen

To prepare the mixing of concrete was essential for the strength of the concrete. Test for compressive strength is carried out on cube. Before the concreting all the materials were weighed and kept ready for concreting as per the mix proportion the size of the cube is 150x150x150 mm and cast for each set. This concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimen should be made even and smooth. These specimens are tested by compression testing machine after 7 days ,14 days and 28 days curing. Load at the failure divided by area of specimen gives the compressive strength of concrete.

3. RESULTS AND DISCUSSION

3.1. Test on compressive strength

The compressive strength obtained for various specimens is as shown in Table 3. The result compressive strength of concrete in various percentages (0, 1, 2, 3, 4%) of nano silica replaced with cement. It observed the strength to be increasing 3% of nano silica replaced with cement

Table 3
Compressive Strength of Concrete (NS replaced with cement)

Specimen	*Compressive Strength*		
	7th day	*14th day*	*28th day*
M1	34.39	35.25	36.48
M2	25.46	26.20	28.60
M3	28.60	30.19	34.33
M4	29.43	32.65	40.44
M5	17.92	19.58	27.00

The result compressive strength of concrete in various percentages (0, 1, 2, 3, 4%) of nano silica adding with cement. It observed the strength to be increasing 3% of nano silica replaced with cement

Table 4
Compressive Strength of Concrete (NS addition to cement)

Specimen	*Compressive Strength*		
	7^{th} day	*14^{th} day*	*28^{th} day*
M1	34.39	35.25	36.48
M2	32.67	34.33	35.57
M3	35.27	35.47	38.11
M4	40.67	43.50	45.63
M5	32.00	37.5	36.48

4. CONCLUSION

This experimental investigation the nano silica is replaced and adding 0,1%,2%,3% of cement and findings the result of compressive strength of concrete. From the above observation, the following conclusion can be obtained.

1. Based on the results, the compressive concrete increases with both adding and replacement of nano silica.
2. The optimum value of compressive strength 40.44 Mpa can be achieved in 3% replacement of Nano silica.
3. The compressive strength 45.63 Mpa can be obtained the Nano silica adding to 3% of cement.
4. At the 7^{th},14^{th} and 28^{th} days result in both adding and replacement of nano silica the compressive strength of concrete was increased in gradually 0,1%,2%,3% both adding and replacing Nano silica by cement and then decreased the value at 4% of replaced the nano silica.
5. When compare to both the observation the high strength of concrete is achieved 3% of NS adding to cement.

REFERENCES

[1] Kawashima S, Hou P, Corr DJ, Shah SP. Modification of cement based materials with nanoparticles. Cem Concr Compos 2013;36:8–15.

[2] Li H, Xiao H, Yuan J, Ou J. Microstructure of cement mortar with nano-particles. Compos: Part B 2004;35:185–9.

[3] Zhang MH, Islam J. Use of nano-silica to reduce setting time and increase early strength of concretes with high volume fly ash or slag. Construct Build Mater2012;29:573–80.

[4] Pacheco-Torgal F, Miraldo S, Ding Y, Labrincha JA. Targeting HPC with the help of nanoparticles: an overview. Constr Build Mater 2013;38:365–7.

[5] A.M. Said , M.S. Zeidan , M.T. Bassuoni , Y. Tian, "Properties of concrete incorporating nano-silica" 36 (2012) 838–844

[6] R. Yu , P. Tang, P. Spiesz, H.J.H. Brouwers A "Study of Multiple effects of Nano-Silica and Hybrid fibres on the properties of Ultra-High Performance Fibre Reinforced Concrete (UHPFRC) incorporating Waste Bottom Ash (WBA)" 60 (2014) 98–110

[7] M. Iyappan , Dr. A. Jagannathan, "High Strength Self Compacting Concrete with Nano Silica." International Journal of Emerging Trends in Engineering and Development Issue 4, Vol.5 (Aug.- Sep. 2014) ISSN 2249-6149.

[8] Mohammad Reza Zamani Abyaneh, Seyed Mahdi Mousavi, "Effects of Nano-Silica on Permeability of Concrete and Steel Bars Reinforcement Corrosion." Australian Journal of Basic and Applied Sciences, 7(2): 464-467, 2013 ISSN 1991-8178.

[9] C. K. Sridhar, S. B. Vanakudre, "Strength Efficiency Factor for Nano Silica at Different Age." International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-3 Issue-6, August 2014.

[10] A. Siva Sai, B.L.P. Swami, B.SaiKiran "Comparative Studies on High Strength Concrete Mixes Using Micro Silica and Nanosilica." International Journal of Engineering and Technical Research (IJETR) ISSN: 2321-0869, Volume-1, Issue-7, September 2013

[11] S. Tanveer Hussain, K.V.S.Gopala Krishna Sastry. "Study of Strength Properties of Concrete by Using Micro Silica and Nano Silica." International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.