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Research paper

Flexural Behaviour and Numerical Simulation on High Strength Nano Silica Concrete

P. Jaishankar[1*], S. Mahalakshmi[2], K. Saravana Raja Mohan[3]

School of Civil Engineering, SASTRA Deemed University, Thanjavur ,Tamilnadu, India.
**Corresponding author: jai@civil.sastra.edu[1]*

Abstract

Effects on Flexural behavior attribute of nano SiO_2 is a most widely used material in cement and concrete to boost the completion because of its pozzolonic reactivity moreover the pore stuffing effect. The results were obtained for mechanical strength, by assorted the reduced contents of 5%, 10%, 15% and 20% NS by volume fraction of cement. For further study, Finite Element Software ANSYS 10.0 is used for modeling and analysis by nonlinear steady flexural strength of the beam by two points loading. The micro structure XRD, XRF diagnosing the migrate properties of high strength concrete, such as permeability and ion transports. Nano silica into concrete mix has shown result of increasing mechanical strength, and flexural behaviour of high strength nano silica concrete. The numerical modeling and experimental inspection circulate that the optimal reduced content of cement with ns is around 15 % of greatest strength increased.

Keywords: *Nano silica, Mechanical strength, Flexural strength, ANSYS 10.0*

1. Introduction

Silicon dioxide nano particles are the identified as greater valuable manufactures of nano technology. If the pieces have characteristic result for the assets of varying manufactures as stated by their little volumes, material properties. In current years, build on the resilience of cement form products has suit a essential element to make better the lifetime of concrete composition. Really, toughness improvement of cement form things can stretch the physical formations of life service. The dynamic method virtue of physical materials depends to a extensive on structural components and occurrence which are strong on a small and nano scale. These powers to aim at material change at the nano structural uniform assurance to release the optimization of material attitude and presentation require progressing differential the mechanical show, capacity deviate properties, strength, and sustainability of concrete. This synopsis the magnitude of the C-S-H phase, the initial component authentic for energy and other assets in cementitious process, lies in a small number of nanometers range. The shape of C-S-H is residue like clay, with fine coatingof solids separated by gel opens filled with interlayer and soak up the water.

2. Nano Silica Concrete

Nano SiO_2 is an indeterminate material with particle size shorter than 100 nm. Which is shorter than the despicable size of silica fume, in this analysis terms with NS with sneaking particle sizes ranged from 17 to 80 nm with about 99% SiO_2.Nano Technology have relevance to concrete restrain the operation of nano materials like Nano SiO_2, nano fibers etc. By attaching the nanomaterials, concrete mixture with better properties can be developed. Adding of nano silica (NS) in concretes and mortars reaction in more capable hydration of cement. This moreover assistance in decreasing the cement requirement, ns amends the small structure and decrease the water permeability of concrete consequently forming it better strength.

3. Experimental Program

Materials

Ordinary Portland cement (OPC) 53 grade was applied which desires of their needs of IS: 12269-1987. Nearby accessible sand together from Cauvery watercourse was utilized. If the fine aggregate was complying with as per IS: 383-1987.For that asuppress aggregate was applied from their nearest area. If the aggregate was utilized for 12.5mm overcome and analysis as per IS: 2386-1963 designation.Conplast SP430 observe with Type 'F' as a strong range water decreasing. Conplast SP430 is granted as a brown liquid immediately dispersible in water. Conplast SP430 has been significantly work out to supply with large water decreases up to 25% among reduction of workability or to generate high feature concrete of decreased permeability.

Table 1 : Properties of cement

Tests types	Test results
Specific gravity	3.15
Initial setting time(min)	30
Final setting time(min)	600

Table 2 : Physical properties of coarse aggregate

Tests types	Conventional aggregate
Maximum size(mm)	12.5
Specific Gravity	2.75
Bulk density(kg/m3)	1800

Table 3 : Physical properties of fine aggregate

Tests types	Fine aggregate
Maximum size (mm)	<4.75
Specific Gravity	2.71

Nano SiO2

Nano Silica (NS) is a mineral blending of elegant material with globular pieces measurement 20 µm in diameter. This is 50 times lower than the common cement particle. Its assets in unique its compressive, bonding strength, and scraping obstacles.

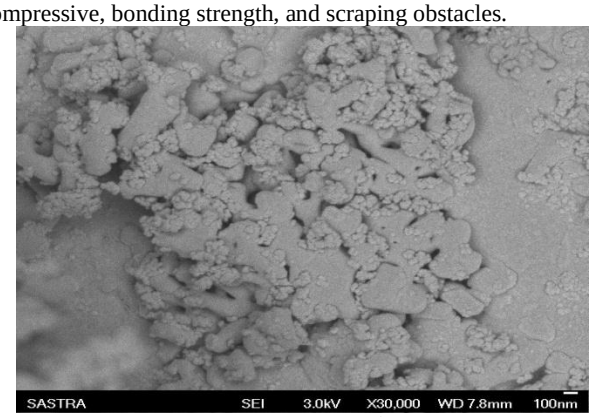

Fig.1 : SEM microstructure of nano silica

Table 4: Properties of Nano silica

Test Item	Standard Requirements	Test Results
SiO_2 Content (%)	≥ 99. 8	99. 88
Carbon Content (%)	≤ 0. 15	0. 06
Chloride Content (%)	≤ 0. 0202	0. 009
Al_2O_3	≤ 0. 03	0. 005
TiO_2	≤ 0. 02	0. 004
Fe_2O_3	≤ 0. 003	0. 001
Specific Gravity	2. 2 –2. 4	2.2
Particle Size	17 nm	17nm
Specific Surface Area (m^2/g)	200 ± 20	202
pH Value	3.7 – 4.5	4. 12
Loss On Drying @ 105^0 C(5)	≤ 1. 5	0. 47
Loss On Ignition @ 1000^0 C (%)	≤ 2.0	0.66
Sieve Residue (5)	≤ 0. 04	0. 02
Tamped Density	40-60	44

Table 5: Peak (detected)

Angle	d value	Intensity	Intensity %
2-Theta °	Angstrom	Count	%
27.227	3.27267	169	100.0
29.735	3.00209	105	61.9

XRD Test

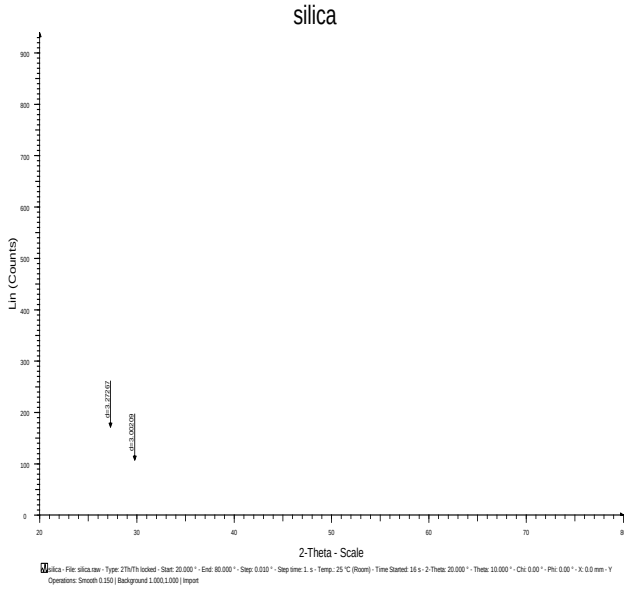

Fig. 2: 2theta scale Background and noise (filtered)

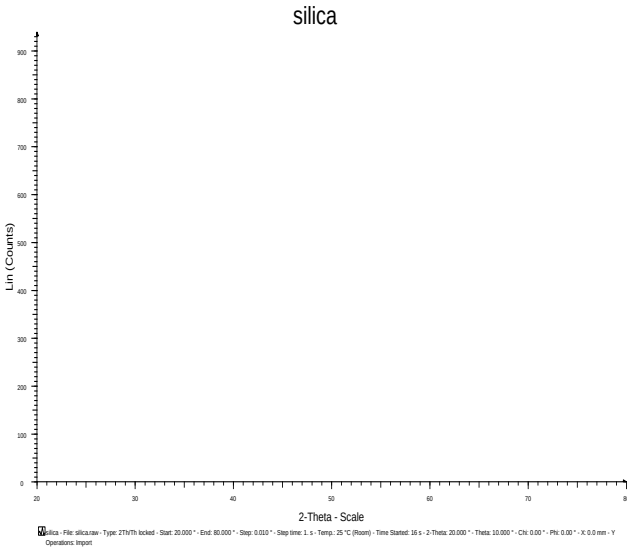

Fig. 3: .Peak (image)

Table 6 : Crystalline (size)

Sample Name	Left Angle	Right Angle	Left Int.	Right Int.	Obs. Max	d (Obs. Max)	Max Int.	Net Height	FWHM	Chord Mid.	I. Breadth	Gravity C.	d (Gravity C.)	Raw Area	Net Area
	2-Theta °	2-Theta °	Cps	Cps	2-Theta °	Angstrom	Cps	Cps	2-Theta °	2-Theta °	2-Theta °	2-Theta °	Angstrom	Cps x 2-Theta °	Cps x 2-Theta °
silica	27.100	27.360	69.1	69.1	27.228	3.27261	169	99.7	0.162	27.229	0.157	27.228	3.27263	33.64	15.68

XRF Test

Chemical composition of nano silica is determined by XRF (X-Ray Fluorescence) test.

Table 7 : Element in oxide form

Formula	Concentration (%)
Si	99.68
Pb	0.14
Cl	0.09
S	0.03
Ca	0.03
Fe	0.02
Zn	0.01

Table 8: Element form

Formula	Concentration (%)
SiO_2	99.61
PbO	0.15
Cl	0.09
SO_3	0.07
CaO	0.04
$Fe2O_3$	0.03
ZnO	0.01

Specimen Preparation

If the assessment work consists of preparation for a high strength concrete. The standard specimens of cubes (150mmx150mmx150mm) and cylinders (150mm Dia x 300mm height) were cast with different percentage reducement of nano silica .The designed Concrete mix was a compressive strength of M_{50} grade with as per ACI 211.4R-93 code. The cement was replaced by NS (0%, 5%, 10%, 15% and 20%).

Casting and Curing

After flowing the combination into casts an dynamic vibrator was utilised to assure superior compaction. If the samples were , apparent level and mask with moistness hessian. All samples were remolded 24 hours besides for their casting. If the behinds of they were cured in ordinary water tank dislocate analysed at period of 7, 28 days.

4. Result and Discussions

Compressive strength Test

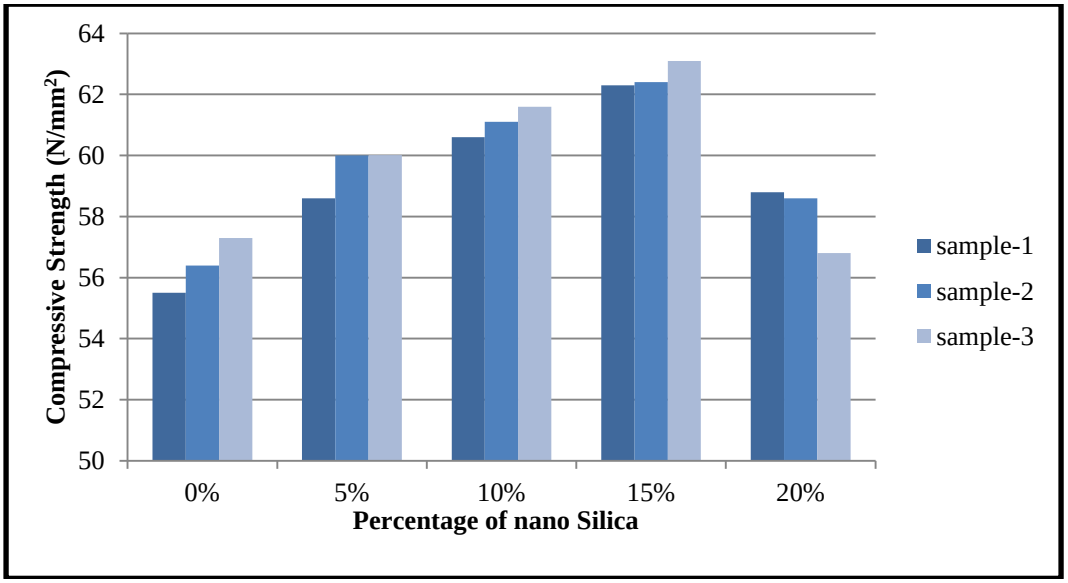

Fig. 4: Compressive strength

The compressive strength test was applied on standard cubes of size 150 mm using compressive testing machine in conformity with BIS (IS: 516-1959). There is a importance in the strength of concrete, since greatest pozzolanic universe of nano silica and their occupying power. The highest 7 days cube strength of M50 grade with 0% of NS was 45.4 N/mm^2. Compressive strength of concrete with NS at 28 days age together displays similar process of grow up to 5% reduced and after that progressively decreased. The greatest 28 days cube strength of M_{50} grade with15% of NS was 63.1N/mm$^{2.}$

Modulus of Elasticity Test

Modulus of elasticity test concrete at 7, 28 days was arranged on cylindrical specimen of 150 mm dia 300 mm height using compression testing machine as stated by the plan of action specified in Indian standards. The modulus of Elasticity Test M_{50} grade concrete and NS concrete at the age of 7days and 28 days are provided. The highest 7 days Cylinder strength of M_{50} grade with 0% of NS was 33.7 N/mm^2.Modulus of Elasticity test of concrete with NS at 28 days age together displays similar process of grow up to 5% reduced and after that progressively decreased. The highest 28 days Cylinder strength of M_{50} grade with 15% of NS was 39.7 N/mm^2.

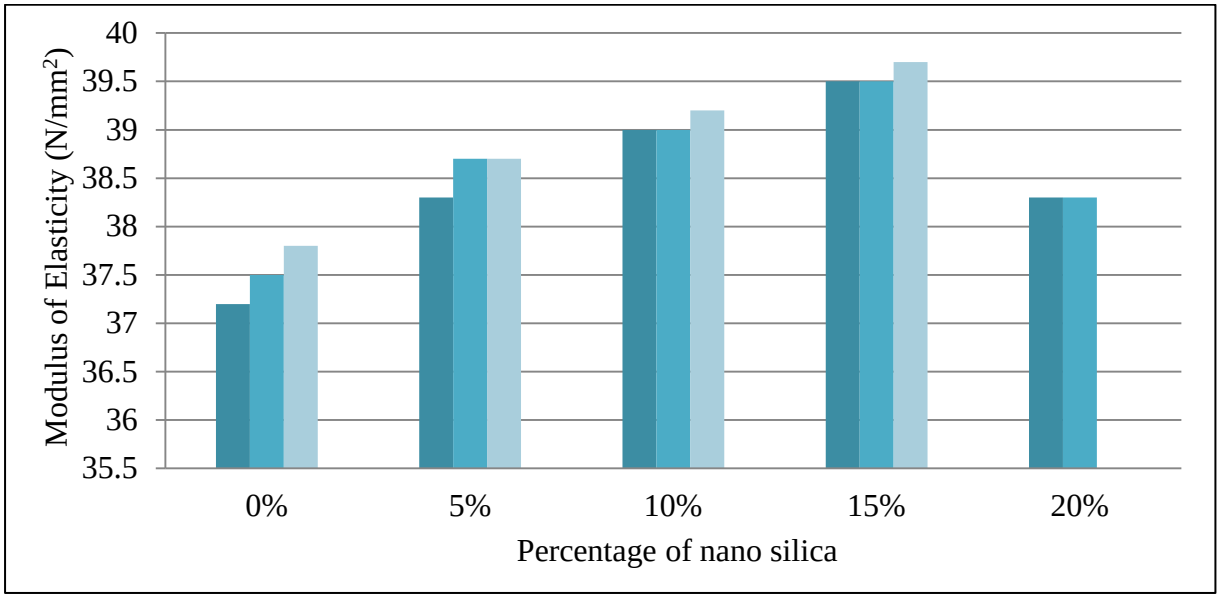

Fig. 5: Modulus of Elasticity Test

Flexural Strength Analysis

It is convenient to conduct numerical analysis of a system without particle damper in ANSYS. For concrete, ANSYS requires input data for material properties are provided. The flexural strength of the beam increase for NS 5% reduced and thereafter it decreases become the results of 15% reduced are until larger than control of concrete. Thus, the increasing an in flexural strength as significantly greater than reaction NS of concrete.

5. Conclusions

High strength concrete is provide to Nano silica, Only small percentage of cement content may be reduced and also it prevent in early cracking and shrinkage with stiffness of concrete structure. The optimized percentage of nano silica is found to be 15%.Increse in percentage beyond the optimized value decreases the compressive strength.The real behavior of the beam ought to be analyzed experimentally and the values obtained experimentally and numerically should be compared.

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References

[1] Anwar and M. Mohamed," Influence of nano materials on flexural behavior and compressive strength of concrete"HBRC Journal, (2016) **12,**212–225.
[2] Sattawat Haruehansapong and Tawich Pulngern, "Effect of the particle size of nano silica on the compressive strength and the optimum replacement content of cement mortar containing nano-SiO2" Construction and Building Materials, (2014) **50**471–477.
[3] Alireza Khaloo and Mohammad Hossein Mobini, "Influence of different types of nano-SiO2 particles on properties of high-performance concrete"Construction and Building Materials ,(2016) **113,** 188–201
[4] Han-Seung Lee and HyeongKyu Cho," Experimental Investigation and Theoretical Modeling of Nano silica Activity in Concrete"Hindawi Publishing Corporation Journal of Nano materials, **12**, 2014, 10
[5] Priyan Mendis and Tuan Ngo, "Compressive strength prediction of nano-silica incorporated cement systems based on a multiscale approach" Materials and Design, (2017)**115,** 379–392.
[6] P.Jaishankar and K.Saravana Raja Mohan "Behaviour of Nano Silica on Strength Characteristics of High Performances Concrete", Revista Română de Materiale / Romanian Journal of Materials, **47** (2017), 470-475.
[7] R. Palla and S.R. Karade," High strength sustainable concrete using silica nanoparticles" Construction and Building Materials,**12** (2017) 285–295.
[8] M.S. Muhidand Norhasri a M.S. Hamidah, "Applications of using nano material in concrete: A review", Construction and Building Materials , (2017)**133** 91–97.
[9] Mohamed Amin and Khaled Abu elhassan," Effect of using different types of nano materials on mechanical properties of high strength concrete" Construction and Building Materials , (2015)**80** 116–124.
[10] Sudhirkumar and V. Barai, "Influence of incorporation of nano-silica and recycled aggregates on compressive strength and microstructure of concrete"Construction and Building Materials ,(2014)**71** 570–578.
[11] Erich D. Rodriguez a and Susan A. Bernal, "Effect of nano silica-based activators on the performance of an alkali-activated fly ash binder"Cement & Concrete Composites, (2013) **35**1–11.
[12] M. Berra a and F. Carassiti,"Effects of nano silica addition on workability and compressive strength of Portland cement pastes" Construction and Building Materials, (2012) **35** 666–675.
[13] P.Jaishankar and K.Saravana Raja Mohan" A Comparative Study on Characterisation and Effect of Micro Silica and Nano Silica" ARPN Journal of Engineering and Applied Sciences, **22** (2017), 6435-6442.
[14] Shiho Kawashima a and PengkunHou," Modification of cement-based materials with nanoparticles" Cement & Concrete Composites, (2013)**36** 8–15.
[15] E. García-Taengua a and M. Sonebi," Effects of the addition of nano silica on the rheology, hydration and development of the compressive strength of cement mortars" Composites Part B , (2015)**81** 120-129.
[16] Alireza Khaloo and Payam Hosseini, "Mechanical properties of fiber-reinforced high-performance concrete incorporating pyrogenic nano silica with different surface areas" Construction and Building Materials , (2015)**101** 130–140.
[17] Ehsan Ghafaria and Hugo Costa, "The effect of nano silica addition on flowability, strength and transport properties of ultra high performance concrete" Materials and Design, (2014)**59** 1–9.
[18] KiachehrBehfarnia andNiloofarSalemi,"The effects of nano-silica and nano-alumina on frost resistance of normal concrete" Construction and Building Materials, (2013)**48** 580–584.