International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 02 | Feb 2022 www.irjet.net p-ISSN: 2395-0072

EFFECT OF NANO-SILICA ON SELF COMPACTING CONCRETE (SCC) AS PARTIAL REPLACEMENT OF CEMENT

Ashish Kumar[1], Preeti kumari[1]

[1]*Assistant Professor, Department of Civil Engineering, Tula's Institute, The engineering & Management College, Dehradun, India*

Abstract - *Concrete is a construction material composed of cement, fine aggregate (sand) and coarse aggregate. The application of nano technology in self-compacting concrete has added a new dimension to the efforts to improve its properties. Nano materials, by virtue of their very small particle size can affect the concrete properties by altering the microstructure. In this research self-compacting concrete has been tested with and without Nano-silica as partial replacements of cement by 0%, 3%, 4% and 5% by the weight of cement. Fresh properties by L-Box, slump test, V-funnel, of concrete has been tested and Compressive strength, tensile strength and flexural strength has been checked after 7 days, 14 days, 28 days and 56 days., consumption of cement in concrete in this research his reduced by replacing cement by Nano-silica. Self-compacting concrete flows and settles under its own weight and any kind of vibration for compaction is not required. Hence, reduces noise and on site manpower (labour) to operate vibrator. Nano-silica is very fine material its size is in Nano range 236 nm and is pozzolanicin nature. The results further revealed that optimum dosage is 4%.*

Key Words: **Nano silica, compressive strength, tensile strength, flexural strength etc.**

1. INTRODUCTION

Concrete is the material of present as well as future. The wide use of it in structures, from buildings to factories, from bridges to airports. Due to the rapid population explosion and the technology boom to cater to these needs. Self-compacting concrete is a special and recent development of concrete in construction world, which flows and fills all the gaps of the formwork/molds under the influence of its own weight, even in congested reinforcement bars. It reduces noise as well due to absence of vibrator at construction site as well as in the plants.

2. MATERIALS USED

2.1. Cement :-

Cement is fine binder, usually organic substance which hardens and adheres to other materials together. In concrete it is used to bind fine and coarse aggregate together. In this study ordinary Portland cement of grade 53 is used produced by Trumbo industries PVT LTD, which sets quickly as compared to 43 grade.

2.2. Fine Aggregates:-

In this study natural sand is used as fine aggregate with specific gravity 2.67 and water absorption of 1%. Moisture content should be supervised closely as this affect the quality of SCC.

2.3. Coarse Aggregate:-

According to EFNARC guidelines and specifications the maximum size of aggregates are limited to 20mm. but in this study I have used 10mm size aggregate with specific gravity 2.65 and water absorption of 0.5%.

2.4. Super plasticizer:-

SCC is made with low water-binder ratio, to compensate water requirement and to decrease viscosity or to increase flow ability of concrete super plasticizer is used. In this study SNF was used as super plasticizer.

2.5. Nano-silica:- Nano-silica was used as partial replacement of cement obtained from ASTTRA CHEMICALS PVT LTD.

3. RESULTS AND DISCUSSION

It is revealed from the results that Nano-silica significantly increases compressive, tensile and flexural strength of Self-Compacting Concrete. It was also revealed that Nano-silica increases water demand as we go on adding this material. Even though the cost of Nano-silica is very high but for lifelong buildings were main motive is its strength properties we can go for Nano-silica. One important thing which observed during experiments was that the surface of specimen was very smooth and there was no requirement of any kind of finishing.

3.1 Fresh properties of concrete

During experimentation it was observed that as we keep on adding Nano-silica, there is increase in water demand. Various tests were performed like L-box, V-funnel, slump flow diameter, T50 slump. First we add 1% super plasticizer to reference mix and all the above mentioned tests were performed and it was revealed from the results that all the values were in range as mentioned in EFNARC. Then we replaced cement by 3% Nano-silica and same quantity of super plasticizer was used, but there was no flow ability in Self-Compacting Concrete. So we keep on adding super plasticizer till we got the results in the range mentioned in EFNARC. Same procedure was repeated for 4% and 5%. Finally we conclude that as we keep on incrementing Nano-

silica more and more requirement of Nano-silica was there by the weight of cement, as presented in table and chart.

Table -3.1: Super plasticizer requirement

Serial No.	Mix id	Requirement of super plasticizer
1	SCC	1 %
2	NSN 3%	1.5 %
3	NSN 4%	1.7 %
4	NSN 5%	2 %

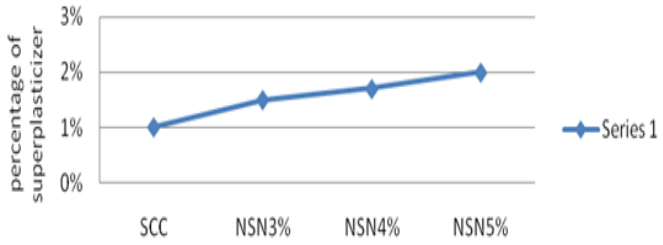

Chart -1: Percentage of Superplasticizer

Various tests as mentioned above were conducted and the results of those tests are presented in table 3.2 below.

Table -3.2: Fresh property results

Mix id	Slump flow	T50 slump sec	L-Box h_2/h_1	V-funnel sec
SCC	714	4	0.93	9
NSN 3%	711	4	0.90	10
NSN 4%	706	5	0.86	10
NSN 5%	713	4	0.91	9

3.2 Hardened properties of concrete

3.2.1. Compressive Strength :-Cubes were tested for compressive strength and the results obtained are presented in table below.

Table 3.3 Average Compressive strength

Mix id	7 Days(N/mm²)	14 Days (N/mm²)	28 Days (N/mm²)	56 Days (N/mm²)
SCC	27	36	45	47
NSN 3%	29	40	48	51
NSN 4%	32	43	52	54
NSN 5%	30	41.5	50	52

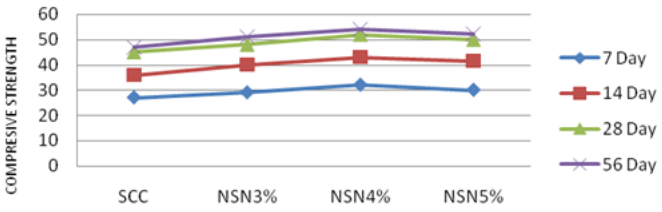

Chart -2: Average Compressive strength

The reason behind increase in compressive strength is reaction mechanism of Nano-silica. Which is pozzolanic nature and nano filling effect of Nano-silica. During hydration of cement that is when cement is reacted with water, Calcium-Hydroxide and Calcium-Silicate hydrate is produced. This produced Calcium Hydroxide is harmful to concrete as this create voids in the concrete so we need to utilize this. So, when we add Nano-silica to concrete as replacement of cement this Nano-silica reacts with this calcium hydroxide and converts this into Calcium-Silica te Hydrate which is cementitious material hence there is significant increase in compressive strength. This is pozzolanic nature of Nano-silica.

3.2.2. Split tensile strength: Split tensile strength results are presented in table below and in figures below.

Table 3.4 Average split tensile strength

Mix id	7 Days(N/mm²)	14 Days (N/mm²)	28 Days (N/mm²)	56 Days (N/mm²)
SCC	3.7	3.9	4.1	4.3
NSN 3%	3.8	4.2	4.5	4.7
NSN 4%	4.1	4.4	4.8	4.95
NSN 5%	3.95	4.31	4.7	4.75

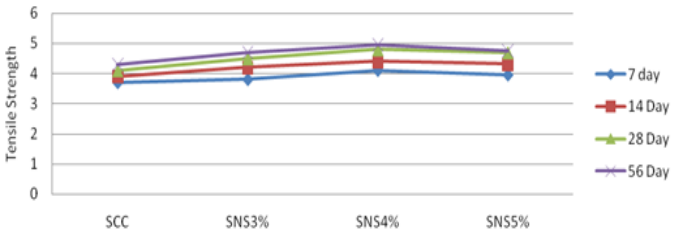

Chart 3: Tensile strength

The main reason behind increase in tensile strength is that there is strong bond formation between aggregates and cement paste but as we keep on increasing percentage of Nano-silica there is agglomeration of concrete which decreases strength of concrete.

3.2.3. Flexural strength:

Table 3.5 average flexural strength

Mix id	7 Days(N/mm²)	14 Days (N/mm²)	28 Days (N/mm²)	56 Days (N/mm²)
SCC	6.1	6.4	7.1	7.3
NSN 3%	6.3	6.65	7.5	7.7
NSN 4%	6.7	6.97	7.8	7.98
NSN 5%	6.45	6.85	7.75	7.84

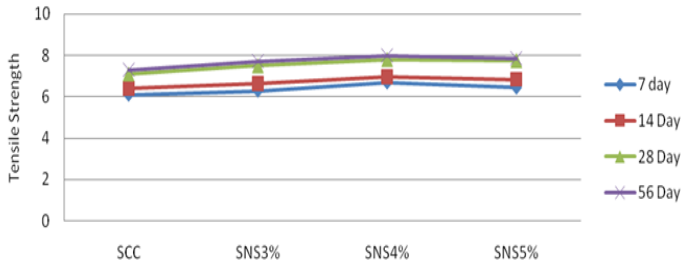

Chart 4: Flexural strength

Reason behind increase in flexural strength is that compressive strength and tensile strength, which is due to pozzolanic nature and nano filling effect of Nano-silica. During hydration of cement that is when cement is reacted with water, Calcium-Hydroxide and Calcium-Silicate hydrate is produced. This produced Calcium Hydroxide is harmful to concrete as this create voids in the concrete so we need to utilize this. So, when we add Nano-silica to concrete as replacement of cement this Nano- silica reacts with this calcium hydroxide and converts this into Calcium-Silicate Hydrate which is cementitious material hence there is significant increase in strength. This is pozzolanic nature of Nano-silica.

4. CONCLUSIONS

- Self-compacting concrete shows more strength properties and is found to be economical as compared to conventional vibrated concrete
- It is revealed that nano-silica in corporate in concrete enhance strength properties and workability as well.
- It is observed that compressive strength increases in mixes incorporated with Nano-silica upto 4% and then it decreases at 5% but is still more than reference mix and mix incorporated with 3% Nano-silica.
- It is revealed that split tensile and flexural strength increases in concrete incorporate with nano-silica up to 4% and then it decreases at 5% but is still more than reference mix and mix incorporated with 3% Nano-silica.
- The reason behind increase in strength is its nano-filling nature and pozzolanic reaction of Nano-silica, by which calcium-silicate-hydrate gel is produced which fills the voids. The fact behind decrease in strength is that, at 5% there is agglomeration form of concrete by which unstable balls are formed which results in decrease in strength.

REFERENCES

[1] G. Quercia, P. Spiesz, G. Husken, H.J.H. Brouwers SCC modification by use of amorphous nano-silica, Cement & Concrete Composites,2014.

[2] Sanga Kranthi Kumar, Influence of Nano-Silica on the Strength and Durability of Self Compacting Concrete, July 2015.

[3] Javier Puentes, Gonzalo Barluenga, Irene Palomar, Effects of nanocomponents on early age cracking of self-compacting Concretes, 2014.

[4] Arya P Nair, Mohammed asim, department of Civil Engineering TKM College of Enginee r ing Kollam, India, Effect of nano silica on the strength and durability properties of glass fiber reinforced self-compacting concrete, 2014.

[5] Erhan Guneyisi, Mehmet Gesoglu, Asraa Al-Goody, Suleyman _Ipek, Fresh and rheologica l behavior of nano-silica and fly ash blended self-compacting concrete, 2015.

[6] S. Rao, P. Silva, J. de Brito, Experimental study of the mechanical properties and durability of self-compacting mortars with nano materials (SiO2 and TiO2), 2015.

[7] Ehsan Mohseni, Bahareh Mehdizadeh Miyandehi, Jian Yang, Mohammad Ali Yazdi, Single and combined effects of nano-SiO2, nano-Al2O3 and nanoTiO2 on the mechanical, rheological and durability properties of self-compacting mortar containing fly ash, 2015.

[8] Ali Nazari, Shadi Riahi, The effects of SiO2 nanoparticles on physical and mechanical properties of high strength compacting concrete, 2011.

[9] IS 516: 1959, methods of test for strength of concrete, Bureau of Indian standard, New Delhi.

[10] IS 516:1999, Split tensile strength of concrete, method of test, Bureau of Indian standard, New Delhi

[11] IS 383:1970, specifications for fine and coarse aggregate from natural sources for Bureau of Indian standard, New Delhi