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# Experimental Investigation on Mechanical Properties of Self Compacting Concrete Using Micro and Nano Silica

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**ABSTRACT:** Self Compacting Concrete (SCC) is popularly used Special concrete in the field of construction. This study is focused on investigating the mechanical properties of SCC using the industrial waste. Nano silica is used as an additive and cement is replaced with the micro silica by weight in varying percentages in concrete. The concrete is put under test for flow properties and mechanical properties like compressive strength and split tensile strength. The objective is to obtain a better flow in concrete without compromising on the strength parameters compared to regular concrete. The industrial waste is often used effectively in concrete mix to boost the properties of the concrete. The combined effect of nano silica and micro silica is found by mixing them simultaneously in self compacting concrete. The SCC is designed for M30 grade of concrete by using the trial and error method.

**KEYWORDS:** Self compacting concrete, nano silica, micro silica.

## I. INTRODUCTION

For the past few decades there has been an immense interest in the materials that are used in the field of construction and concrete has played an important role and it is still very popular material in the construction industry. Concrete has been put to many modifications by varying the materials which are added in it and one such material which has come to the limelight is the nano dimensional materials and micro dimensional materials, these materials can enhance and improve the various properties of concrete when added. This can be one of the best alternatives for the modification of the concrete material. There are varieties of theoretical and practical experiments which are conducted all across the world in the nano dimension field and they are observed and analysed for their part in the construction field and for the influence in concrete's mechanical and rheological properties.

There are many special types of concretes and each type has its own advantage in improving different properties of concrete and one such special type of concrete is self compacting concrete or self consolidated concrete(SCC). This type of concrete is focused to enhance the flow properties or workability of concrete, in which the concrete should flow on any surface under its own weight without forming any voids and it should also ensure that there is no segregation and no problem in filling and passing ability. SCC needs no additional ability for compaction through vibration, which eventually reduces the use of costly machines for compaction. SCC previously has performed well in flowing ability and with few more modifications to the concrete like introducing the nano dimensional material can be a sound idea to improve workability without compromising on the mechanical properties of the concrete in the hardened state. Whilst the use of superplasticizer maintains the fluidity, the fine content provides stability of the mix resulting in resistance against bleeding and segregation. It is estimated that SCC may result in up to 40% faster construction than using normal concrete. The elastic modulus and shrinkage of SCC may not differ significantly from the corresponding properties of normal concrete.



II. LITERATURE REVIEW

The concept of nano particle inclusion in cement concrete is used in Pawel niewiadomski et al. [1] with their study has shown the influence of nano additives on the mechanical and physical properties of hardened self-compacting concrete (SCC). In this project compressive strength was increased in the case of SiO<sub>2</sub> addition. Different amounts of SiO<sub>2</sub>, TiO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub> nano-additives and one reference concrete made without nano-particles was used. Heba a. Mohamed [2] This study presents an experimental study on self-compacting concrete (SCC) with two cement content. The work comprises of three types of mixes, the first, second and third consists of different percentages of fly ash (FA), uses different percentages of silica fume (SF), and uses admixture of FA and SF respectively. The results show that SCC with 15% of SF gives higher values of compressive strength than those with 30% of FA and water cured specimens for 28 days give the highest values of compressive strength. Piotr smarzewski [3] the main aim of this study is to determine the fracture energy of high performance concrete (HPC) containing silica fume (SF). Additions of SF into the HPC were 0%, 5%, 10%, 15%, 20% and 25% by weight of cement content. The water/binder ratio was 0.25. The use of SF increased all tested mechanical properties of concrete. Damian Stefaniuk et al. [4] Investigations included SCC concretes modified with different amounts of SiO<sub>2</sub>, TiO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub> nanoparticle additives and one reference concrete made without nanoparticles. It can be concluded that the addition of nanoparticles improves the microstructure of self-compacting concrete. It is confirmed both by the results of porosity of the tested samples and by the results of hardness and elastic modulus of the cement matrix of investigated concretes. Jefferson de santana jacob et al. [5] Since the chemical attack in cementitious structures is controlled by its porosity and permeability, the use of mineral admixtures in cement is convenient. This work evaluated the behaviour of cement mortars with nano-silica and silica fume (micro-silica) to an acid attack, simulating the effects of acids present in pig manure to cementitious materials. M. Rezanía et al. [6] In this research, the simultaneous incorporation of nano-carbon black and nano-silica in the concrete with nine different mixing patterns is considered to investigate the permeability and mechanical properties of the concrete.

III. METHODOLOGY

The methodology provides an idea on the process of the experiment carried out. In this project cement is replaced with the micro silica and an additive of nano silica is added. The nano silica in 0%, 0.5 and 1% are added as an additive and cement is replaced with micro silica in 5%, 10% and 15% keeping the nano silica percentage as 0.5%. Concrete is mixed in a specific design for M30 grade of concrete.

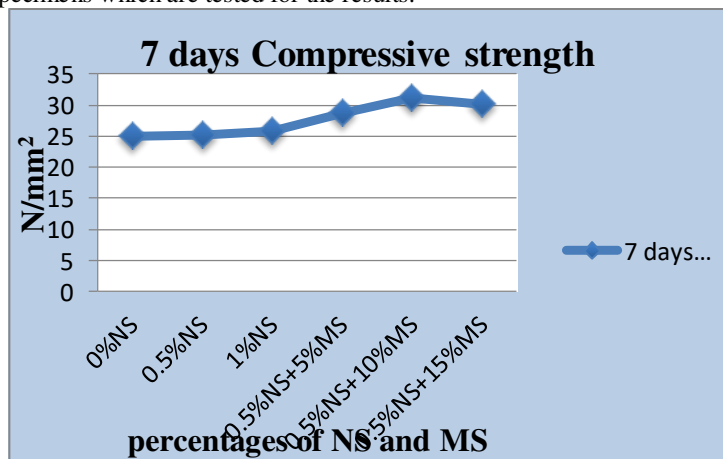
The SCC is designed as per the flow properties of the guide lines specific in EFNARC. The mixed design is done based on trial and error method. This project took a total of 6 different trials to get a good flow of the concrete. After the concrete cube is casted and done with curing, the cube is tested for compressive strength and split tensile strength.

IV. EXPERIMENTAL RESULTS

Compressive strength of concrete is the capacity of the concrete to take the compressive loads axially without any failure. As per IS: 516-1959 the concrete cubes of dimensions 15cmx15cmx15cm are casted and are tested after a period of 7, 14 and 28 days of curing. For each sample there are three specimens which are tested for the results.

S No.	Type of specimen	Avg. compressive strength of SCC(N/mm <sup>2</sup> )
1	0%NS	24.92
2	0.5%NS	25.15
3	1%NS	25.73
4	0.5%NS+5%MS	28.76
5	0.5%NS+10%MS	31.2
6	0.5%NS+15%MS	30.1

(a)

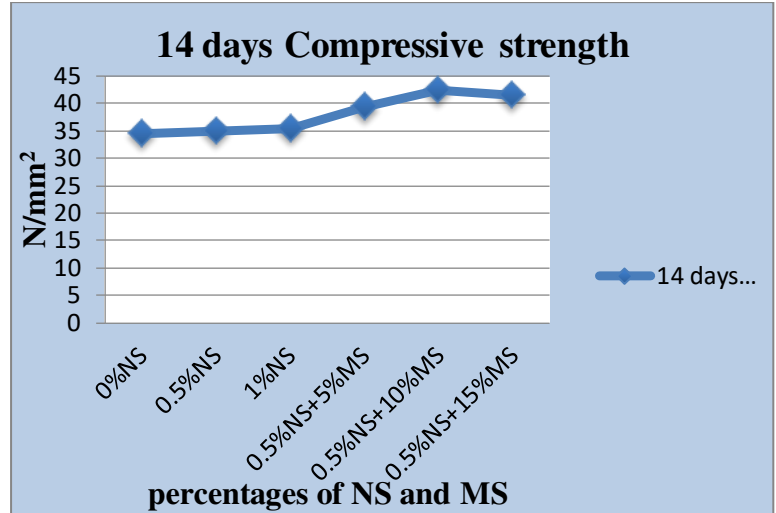


(b)

Fig.1 Compressive strength of 7 days (a) Table for 7 days (b) Graph for 7 days

S No.	Type of specimen	Avg. compressive strength of SCC(N/mm <sup>2</sup> )
1	0%NS	34.43
2	0.5%NS	34.97
3	1%NS	35.52
4	0.5%NS+5%MS	39.4
5	0.5%NS+10%MS	42.5
6	0.5%NS+15%MS	41.4

(a)

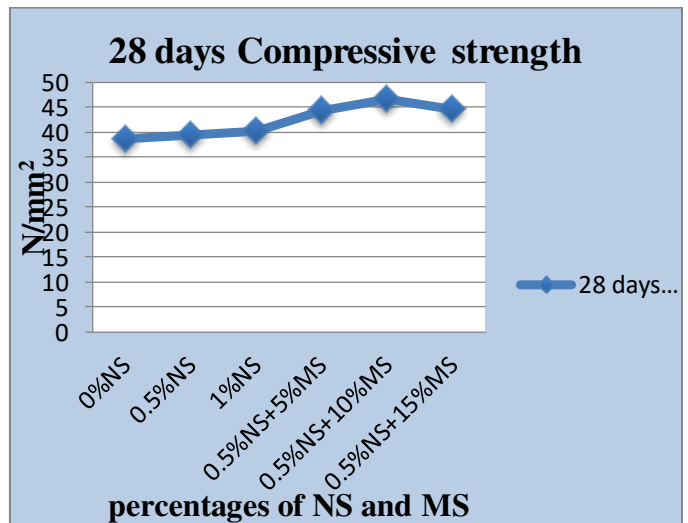


(b)

Fig. 2 Compressive strength of 14 days (a) Table for 14 days (b) Graph for 14 days

S No.	Type of specimen	Avg. compressive strength of SCC(N/mm <sup>2</sup> )
1	0%NS	38.54
2	0.5%NS	39.41
3	1%NS	40.20
4	0.5%NS+5%MS	44.3
5	0.5%NS+10%MS	46.62
6	0.5%NS+15%MS	44.5

(a)



(b)

Fig. 3 Compressive strength of 28 days (a) Table for 28 days (b) Graph for 28 days

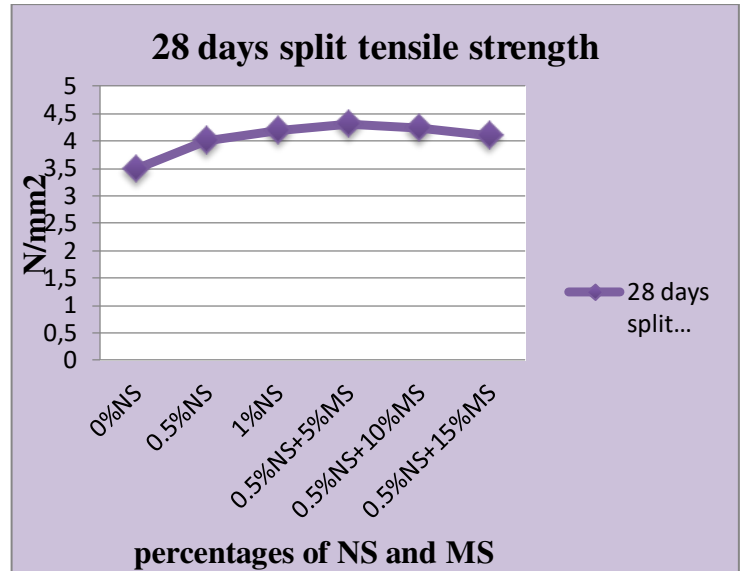
The split tensile strength can be describes as to determine the tensile strength of concrete which splits the concrete along the vertical axis of the specimen. The split tensile strength is usually done for the cylindrical specimen where the cylinder is subjected to load on the curved side or load is applied in the direction perpendicular to the vertical axis of the cylindrical specimen. There after the cylinder tends to split in two parts along the vertical axis.

The tests are usually done following the IS 516 and IS 5816 which gives an idea of performing the test in different ways for various types specimens. For the experiment, the specimen type is a cylinder of dimensions 15cm dia and 300cm height which has been casted for the 6 types of samples and three specimens for each sample mix.

The concrete specimen is put to a gradually increasing load ranging from 1.2N/ (mm<sup>2</sup>/min) to 2.4N/ (mm<sup>2</sup>/min). The cylinder subjected to load shall be placed in such a manner that the load is applied only on curved surface that is the cylinder's axis should be in the horizontal direction and the load should act perpendicular to the axis of the cylinder. This ensures the correct position of the specimen in the testing machine for the test to be conducted.

S No.	Type of specimen	Avg. split tensile strength of SCC(N/mm <sup>2</sup> )
1	0%NS	3.5
2	0.5%NS	4.0
3	1%NS	4.2
4	0.5%NS+5%MS	4.31
5	0.5%NS+10%MS	4.23
6	0.5%NS+15%MS	4.1

(a)



(b)

Fig. 4 Split tensile strength of concrete after 28 days of curing (a) Table (b) Graph

### V. CONCLUSION

The SCC design for various samples have shown different kind of results which are evident to scrutinize and can be concluded as follows

- The inclusion of NS up to 0.5% and MS up to 5% has shown an increase in the workability of the concrete. The workability of the above sample of SCC mix got increased up to 5% when compared to the sample without any addition of NS and MS.
- As the percentage of MS increased in SCC, the workability got decreased and it became the worst for the sample 0.5%NS+15%MS, where it lost up to 4% of its workability compared to the sample without any addition of NS and MS.
- The compressive strength of the SCC has shown an appreciable increase when the MS content is increased in the concrete mix up to 10% MS. There after strength got decreased for 0.5%NS+15% MS.
- The increase in the compressive strength for the sample 0.5%NS+10%MS is up to 20% when compared to the sample without any addition of NS and MS. For the sample 0.5%NS+5%MS has shown an increase in compressive strength up to 15% compared to normal SCC sample mix.
- The split tensile strength for the concrete mix has also shown an increase with the increased percentage replacement of the MS in SCC. The best result was observed for the sample 0.5%NS+5%MS.
- SCC has shown up to 23% increase in the split tensile strength of the concrete for the sample 0.5%NS+5%MS compared to normal SCC sample mix.

From the above specified points we can conclude that the sample 0.5%NS+5%MS can be a best alternative for the normal SCC mix because it has shown an optimum increase in workability and also in compressive strength of SCC.

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