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Experimental Investigations on Nano Silica in Concrete

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Keywords: Normal conventional concrete has been widely used as a construction material throughout the world because of its advantages of high compressive strength, durability, workability, mould-ability, etc. The current global scenario shows increased construction of large and complex structures with heavy reinforcement and complicated shapes. Using normal concrete in such situation may often result in inadequate compaction, affecting performance and long-term durability of tructures. One solution for the achievement of durable concrete structures is the use of Self-Compacting Concrete (SCC). At present day Nanotechnology is one of the most active research areas which has wide applications in almost all the fields. So, in these project, improving SCC concrete properties by addition of nano-silica particles and compare the test results with conventional concrete. To study the Effect of nano-silica in the properties of self compacting concrete (SCC). SCC + Nano Silica. Conventional SCC (0% nano silica). In addition to that finding the mechanical properties (i.e. Compressive strength, Split- tensile strength, Flexural strength) were also evaluated. After evaluating the mechanical properties for the various mix andit is compared with the conventional concrete. Well dispersed nano particles increase the viscosity of the liquid phase, improves the segregation resistance and workability of the system. Accelerates the hydration. Better bond between aggregates and cement paste. Improves the toughness, shear, tensile strength and flexural strength of concrete.
***Keywords:** Nano Silica, Self compacting concrete, compressive strength.*

I. INTRODUCTION

Self-compacting concrete (SCC) was first developed inJapan (in the mid to late 1980s) as a means to create uniformity in the quality of concrete by controlling the ever present problem of insufficient compaction by a workforce that was losing skilled labor and by the increased complexity of designs and reinforcement details in modern structural members. Durability was the main concern and the purpose was to develop a concrete mix that would reduce or eliminate the need for vibration to achieve consolidation. The use of SCC concrete has been increasing in the United States also during the last 5 years. Currently the technology is being primarily applied to the precast industry. Other segments being targeted are flatwork, columns and wall construction. The applications of SCC are many, limited only by the industry's knowledge of it, ability to produce it and acceptance of it.The usual self-compacting concretes have compressive strengths in the range of 60-100N/mm². However Ultra High Performance Self-Compacting Concrete (UHPSCC) with strength about 150 N/mm²have also been successfully developed.The durability of cement concrete is defined as its ability to resist weathering action, chemical attack, abrasion or any other process of deterioration. Durable concrete will remain its original form, quality and serviceability when exposed to its environment.AhamadAskariet.al (2011)Anexperimental investigation into mechanical properties of self compacting concrete incorporating fly ash and silica fume at different ages of curing. Self compacting mixtures had a cement replacement of 20,30 and 40% with class F fly ash and 5,10 and 15% with silica fume. the results show that normal strength self compacting concrete could be successfully produced using fly ash and silica fume.MuctebaUysalet.al (2011) has investigated performance of self-compacting concrete containing different mineraladmixtures.The influence of mineral admixture on a workability, compressive strength, ultrasonic pulse velocity, density and sulphate resistance of SCC was investigated.KemalettinYilmazet.al (2011) has investigated effect of mineral admixtures on properties of self compacting concrete Limestone powder (LP), Basalt powder(BP) and marble powder(MP) are used directly without attempting any additional processing in the production of SCC.C.Selvamonyet.al (2010) has investigation on self compacted self-curing concrete using limestone powder and clinkers which the use of Silica fume in concrete increased the dosage of super plasticizers. At the same constant sp dosage 0.8% and mineral additive constant 30%, LP can better improve the workability than that of control and fine aggregate by 5% to 45%.S.VenkateswaraRaoet.al (2010) has investigation of effect of size of aggregate10mm size aggregate and 52% fly ash in total powder the mechanical properties were superior in standard SCC, while 16 mm size aggregate with a 31% fly ash in total powder improved the properties of high strength SCC.R.Ilangovana[1]et.al (2008) has investigation of strength and durability properties of concrete containing quarry rock dust as fine aggregate on Quarry Rock

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Dust can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of rocks to form fine particles less than 4.75mm. Mehmet Gesogluet.al (2007) has investigation on effect of mineral admixtures on fresh and hardened properties of self compacting concrete binary,ternary and quaternary systemsthe Test results have revealed that incorporating the mineral admixtures improved the fresh properties and rheology of the concrete mixtures.M.a.ahmadiet.al (2007) has investigation on two different replacement percentage of cement by RHA, 10% and 20%,and two different water/cementicious material ratios (0.40 and 0.30), were used for both of self compacting and normal specimens.Hui-sheng shiet.al (2007) has investigation on determination of gas permeability of high performance concrete containing fly ash Gas permeability of high performance concrete(HPC) with water/binder ratio varying from 0.25 to 0.35 and level of fly ash replacement ranging from 0% to 60% were determined.

II. MATERIALS AND METHODS

A. *Ordinary Portland Cement*

Portland cement is a fine powder comprised of a minimum of 66% calcium silicate, with the remainder largely being a mix of aluminum, and iron. Portland cement is a hydraulic material, which requires the addition of water in order to form exothermic bonds, and is not soluble in water.

Table 1. Propertirs of cement

S. No.	Property Of Cement	Values
1	Fineness Of Cement	7.5%
2	Grade Of Cement	53
3	Specific Gravity	3.15
4	Initial Setting time and final setting time	28 min& 600 min

B. *Coarse Aggregates and fine aggregate in concrete*

Crushed angular granite metal of 20 mm size from a local source was used as coarseaggregate.River sand was used as fine aggregate in the investigation.

Table 2. Propertirs of aggregate

S. No.	Properties	Values
1	Specific Gravity (Fine aggregate)	2.705
2	Fineness Modulus	2.75
3	Specific Gravity (Course aggregate)	2.861

C. *Super-plasticizers*

GLENIUM B233 consists of a carboxylic ether polymer with long side chains. At the beginning of the mixing process it initiates the same electrostatic dispersion mechanism as the traditional super-plasticizers, but the side chains linked to the polymer backbone generates a steric hindrance which greatly stabilizes the cement particles ability to separate and disperse. Steric hindrance provides a physical barrier (alongside the electrostatic barrier) between the cement grains. With this process, flow able concrete with greatly reduced water content is obtained. The optimum dosage of SP should be determined with trial mixes.

D. *Nano Silica*

The concrete mixtures investigated in this studywere prepared with Portland cement type II, Micro silica powder and nanosilica.Thespecificgravity of microsilica and nanosilica is 2.17 and1.03, and they are silica particles with a maximumsize of 0.2 μm and 50 nm, respectively. In addition,nanosilica is a water emulsion with 50 % of drysolid and PH of 10.. The controlmix which was exclude of microsilica andnanosilica.

Table 3. Mix proportions of concrete

Materials	% of Proportions	Cement	Fine aggregate	Coarse aggregate	Silica	water	Super plasticizers
Micro Silica	5%	460.75 kg/m^3	995 kg/m^3	1114 kg/m^3	24.25 kg/m^3	156 litres	9.7 kg/m^3
	10%	436.5 kg/m^3	995 kg/m^3	1114 kg/m^3	48.5 kg/m^3	156 litres	9.7 kg/m^3
	15%	415 kg/m^3	995 kg/m^3	1114 kg/m^3	73 kg/m^3	156 litres	9.7 kg/m^3
	20%	388 kg/m^3	995 kg/m^3	1114 kg/m^3	97 kg/m^3	156 litres	9.7 kg/m^3
Nano Silica	2%	475 kg/m^3	995 kg/m^3	1114 kg/m^3	9.7 kg/m^3	156 litres	9.7 kg/m^3
	3%	473 kg/m^3	995 kg/m^3	1114 kg/m^3	12.45kg $/m^3$	156 litres	9.7 kg/m^3
	4%	466 kg/m^3	995 kg/m^3	1114 kg/m^3	19.4 kg/m^3	156 litres	9.7 kg/m^3

Fig 1. Nano and micro silica

Table 4. Chemical composition of micro silica

Chemical composition	%
SiO_2	85-95
C	0.6 -1.5
Fe_2O_3	0.4-2
Cao	2-2.3
Al_2O_3	0.5 – 1.7
MgO	0.1 – 0.9

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III. RESULTS AND DISCUSSION

A. Compressive Strength

Compression test develops a rather more complex system of stresses. Due to compression load, the cube or cylinder undergoes lateral expansion owing to the Poisson's ratio effect. The steel plates do not undergo lateral expansion to the some extent that of concrete, with the result that steel restrains the expansion tendency of concrete in the lateral direction. This induces a tangential force between the end surfaces of the concrete specimen and the adjacent steel plates of the testing machine. It has been found that the lateral strain in the steel plates is only 0.4 of the lateral strain in the concrete. Due to this the platen restrains the lateral expansion of the concrete in the parts of the specimen near to its end. The degree of restraint exercised depends on the friction actually developed. when the friction is eliminated by applying grease, graphite or paraffin wax to the bearing surfaces the specimen exhibits a larger expansion and eventually splits along its full length.The cube specimen is of the size 15 x 15 x 15 cm. If the largest nominal size of the aggregate does not exceed 20 mm, 10 cm size cubes may also be used as an alternative. Cylindrical test specimens have a length equal to twice the diameter. They are 15 cm in diameter and 30 cm long. Smaller test specimens may be used but a ratio of the diameter of the specimen to maximum size of aggregate, not less than 3 to 1 is maintained

Fig 2. Test Specimen

Table 5. Compressive Strength result

SI.NO.	Nano Silica(%)	7^{th} day (N/mm^2)	28 days (N/mm^2)
1.	0	24	52
2.	2	24.45	52.55
3.	3	26.75	52.90
4.	4	26.65	53.10
S.NO.	Micro Silica (%)	7^{th} day (N/mm^2)	28 days (N/mm^2)
1	o	24	52
2	5	26	53.75
3	10	28.45	56.85
4	15	31.75	60.50
5	20	21.65	55.75

B. Split Tensile Test

Tensile strengths are based on theindirect splitting test on cylinders. This is also sometimes referred as, "Brazilian Test". This test was developed in Brazil in 1943. At about the same time this was also independently developed in Japan.The test is carried out by placing a cylindrical specimen horizontally between the loading specimen of a compression testing machine and the load is applied until failure of the cylinder, along the vertical diameter. The loading condition produces a high compressive stresses immediately below the two generators to which the load is applied. But the larger portion corresponding to depth is subjected to a uniform tensile stress acting horizontally. It is estimated that the compressive stress is acting for about 1/6 depth and the remaining 5/6 depth is subjected to tension.

Fig 3. Test Specimen- cylinder

Table 6. Split Tensile Strength Results

SI.NO.	Nano Silica(%)	28 days
1.	0	3.95
2.	2	3.98
3.	3	4.15
4.	4	4.10
S.No.	% of Micro Silica	28 days
1	o	3.95
2	5	4.10
3	10	4.7
4	15	4.96
5	20	4.92

C. Flexural Strength

The mould should be of metal, preferably steel or cast iron and the metal should be constructed with the longer dimension horizontal and in such a manner as to facilitate the removal of the moulded specimens without a damage. The tamping bar should be steel bar weighing 2 kg, 40 cm long and should have a ramming face 25 mm square.The testing machine may be of any reliable type of sufficient capacity for the tests and capable of applying the load at the rate specified. The permissible errors should not be greater than ± 0.5% of the applied load where a high degree of accuracy is required and not greater than ± 1.5% of the applied load for commercial type of use. The bed of the testing machine should be provided with two steel rollers, 38 mm in diameter, on which the specimen is to be supported.

Fig 5. Test Specimen – beam

Table 6. Flexural strength results

S.No.	Nano Silica(%)	28 days (Mpa)
1.	0	5.0
2.	2	5.15
3.	3	5.20
4.	4	5.20
S.No.	% of Micro silica	28 days (Mpa)
1	o	5.0
2	5	5.20
3	10	5.68
4	15	5.95
5	20	5.60

IV. CONCLUSION

Based on experimental research for three self compacting concrete mixes(only microsilica,nanosilica, combination of micro and nano silica), the following conclusions can be drawn at 28 days.Due to observed workability and high flow ability of SCC, it can be used in highly congested reinforcement structure as compare to conventional concrete.Using nano silica in SCC individually there is no greater differences in strength gaining as compared to conventional concrete, but it as improve the flexural strength upto 5% using 3% of micro silica.The concrete with addition of 15% micro silica(based on the mass of cement) in SCC, the compressive strength, split tensile strength, flexural strength increased by 22%, 25%, 19% respectively.As a general conclusion, the comparison results of micro silica, nano silica, combination of micro silica and nano silica specimen indicated that, a more suitable and strength gaining in SCC is combination of micro silica and nano silica, that is concrete with combination of 15% of micro silica and 3 litres of nano silica improve the compressive strength, split tensile strength, flexural strength by 25.61%, 25%, 19% respectively.

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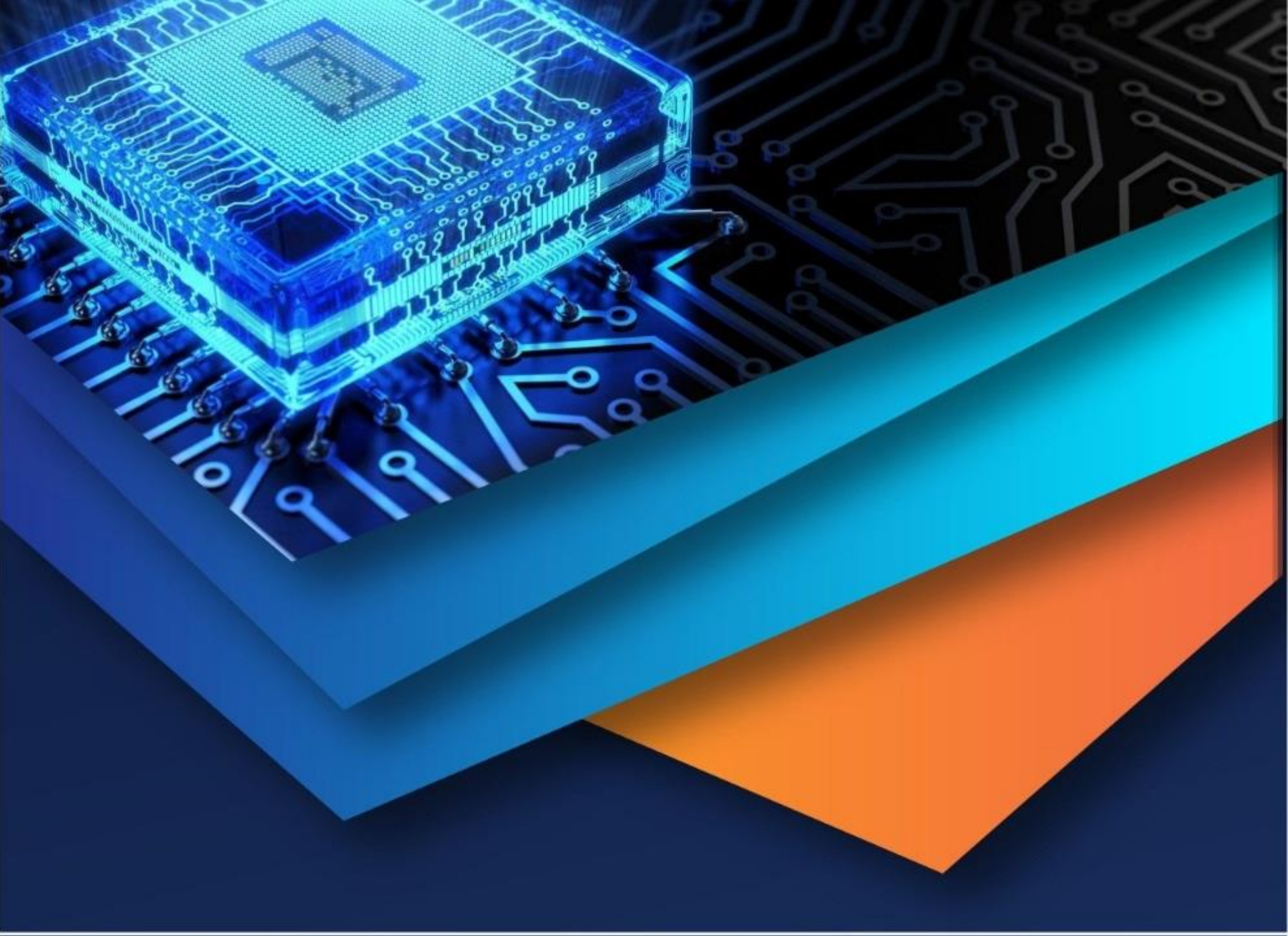

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