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A STUDY ON THE HIGH STRENGTH CONCRETE PROPERTIES USING NANO SILICA AND MICRO SILICA

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Abstract – *Concrete is the most adaptable of all the materials. Due to the constant need for concrete to fulfill a variety of challenging criteria, substantial and comprehensive study in the region of concrete knowledge has been conducted. Scientists continue to push the boundaries of show by means of the assistance of chemical additives and supplemental cement like materials (alike as fly ash, silica fume, granular blast furnace slag and so on). Nano-structured concrete is a novel kind of concrete that is made up of cement, nano-silica particles ranging in size from 10nm to 140nm, water, and fine aggregate and coarse aggregate. Currently, nano-structured similar to as nano-silica, nano-titania, carbon nanotubes, nano-alumina, and others are utilised in concrete to alter its strength qualities. Nano-structured and other large-scale materials have distinct properties and purposes. Nano-structured materials have a greater shell area and quantity than greater particles of equivalent dimension, assembly them more reactive. CSH2 is formed when nano-silica interacts with C3S and C2S in the cement to produce a strong and tight gel bond. Micro-silica fume (5%, 7.5%, 10%, 15%) and nano-silicic acid (1%, 1.5%, 2%, 2.5%) were employed as cement replacements in this investigation. Experiments have shown that micro SF, NS, and a mixture of micro SF and NS may be utilised to produce concrete composites with superior characteristics.*

***Key Words*: Compressive Strength, Split Tensile Strength, Flexural Strength, Nano Silica(NS), Micro Silica(SF).**

1.INTRODUCTION

Cement, aggregates, and water will make up the majority of concrete. Due to its solid structure and strength, it is a commonly utilised building material for a variety of buildings. The rise in event problems in assembly, along with new materials and production processes, has given rise to a innovative foundation in favour of the construction of high-performance concretes. Concrete is now utilised for a extensive range of purposes, allowing it to be worn in a extensive range of situations. Conventional concrete may not have the necessary quality or strength in these situations. Common mineral or pozzolanic admixtures will alter the characteristics of ordinary concrete in such circumstances.

Concrete is one of the most essential and vital means of employing technology in technology. It's utilisation in a multiplicity of construction projects, counting highways, bridges, buildings, and other structures. The precise units of measurement tend to alter in a variety of ways; one of them must comprise nano particles in each. At the nano scale, scientists are interested in learning more about the fine structure of cement-based materials. This might lead to a latest age band of concrete that is both well-build and more tough, as well as having the necessary characteristics. The cement's consolidation results in a strong, heterogeneous microstructure. The overall characteristics of artefact materials, like as strength, are governed by these small structural phases.

2. EXPERIMENTAL METHODS AND MATERIALS

2.1. Cement

The radical school cement of standard hydraulic cement (OPC) of fifty three grades was utilised in this gift research to meet the needs of IS: 12269-1987. The following experiments were carried out on cement.

Physical Tests	Obtained Results
Fineness	4%
Standard Consistency	31 %
Initial Setting time	120 min
Final setting time	250 min
Soundness	3 mm
Specific gravity	3.11

Table 1. Properties of Cement

2.2. Silica Fumes

The SF utilized in the mentioned tests met ASTM C 1240 and IS 15388:2003 standards. SF is a very tiny particle that comes in the outward appearance of a white powder. Astrra chemicals Ltd in Chennai provided the oxide fume.

Physical Properties	Results	Chemical Properties	Results
Physical state	Micronized Powder	Silica (SIO2)	99.886%
Odour	Odourless	Alumina (Al2O3)	0.043%
Appearance	White Colour Powder	Ferric Oxide (Fe2O3)	0.040%
Colour	White	Titanium Oxide (TiO2)	0.001%
Pack density	0.76 gm/cc	Calcium Oxide (CaO)	0.001%
PH of 5% solution	6.90	Magnesium Oxide (MgO)	Absent
Specific Gravity	2.63	Potassium Oxide (K2O)	0.001%
Moisture	0.058%	Sodium Oxide (Na2O)	0.003%
Oil absorption	55 ml / 100 gms	Loss on Ignition	0.015%

Table 2. Properties of Silica Fumes

2.3. Nano Silica

NS is a sequence of oxide-root mainly worn for packing the gaps acquired from Bee-chem.: Chemicals Ltd., Kanpur, and is used in this experimental investigation.

State	Dispersed in water
Active nano particle Content (%w/w)	40.00-41.50
PH (at 20° C temperature)	9.0-10.0
Specific gravity	1.30-1.32
Particle size	5-40 nm

Table 3. Properties of NS

2.4.Fine Aggregate

Sand obtained from the watercourse Tungabhadra was utilised domestically. The following tests were carried out on a fine mixture in accordance with IS: 383-1987.

Properties	Results
Bulk density, kg/m^3	1650
Specific gravity	2.68
Fineness modulus	2.81

Table 4. Properties of Fine aggregate

2.5.Coarse Aggregate

Aggregate was acquired from a within reach excavation. The aggregate utilised in this experiment was 20mm down and experimented according to IS: 2386-1963(I,II,III) specifications. The following experiments were carried out on a coarse mixture.

Property	Results
Maximum nominal size	20mm
Bulk density (kg/m^3)	1800
Specific gravity	2.75

Table 5. Properties of Coarse aggregate

2.6. Super-plasticizer

For M40 and M50 concrete grades, Fosroc Aura mix four hundred was utilised.

Properties	
Appearance	Light yellow coloured liquid
PH	About 6.0
Volumetric mass @ 20°C	1.09 kg/ litre
Chloride content	Nil
Alkali content	Typically less than 1.5 g Na_2o equivalent liter of admixture

Table 6. Properties of Super-plasticizer

3. OBJECTIVE

The purpose of this experiment is to investigate the strength characteristics of concrete using nano silicon dioxide and silicon dioxide fume as partial replacements for cement in M40 and M50 grade concretes. Concrete strength features like as compressive strength, split tensile strength, and flexural strength are achieved by substituting regular Portland cement by silicon dioxide fume, as well as nano silicon dioxide. The strength characteristics of M40 and M50 grade concretes were also investigated meant for a combination of optimal SF (7.5%) and NS replacement levels (2%).

4. METHODOLOGY

4.1. Compressive Strength

The cubes are tested using two types of samples, involves on the dimensions of the unit. The majority of the work is done with 15cm x 15cm x 15cm cubic forms. This concrete is discharged into the mould and tampered correctly to get rid of air bubbles. The moulds are separated after a day, and the experimental samples are lay in water to cure. The mentioned samples ought to have a level and even upper face. This can be accomplished by put in the cement paste to the entire upper surface of the sample and spreading it uniformly. After 28 days, the above mentioned samples are examined on a compression testing apparatus. The load should be supplementary progressively until the samples fail, at a rate of 140 kg / cm2 per minute.

$$\text{Compressive Strength} = \frac{\text{Applied load}}{\text{Area}}$$

Fig 1. Compressive Strength Testing

4.2. Split Tensile Strength

Concrete's tensile strength is one of the most significant characteristics that influences the severity and extent of cracks in buildings. Furthermore, due to its brittleness, concrete is particularly weak under tension. As a result, it is unlikely to resist forward loading. When tensile pressures surpass the strength of concrete, fractures develop. Since, the tensile strength of concrete has to be resoluted in order to estimate the load at what value concrete components can break. Furthermore, a method for evaluating the tensile strength of concrete is the tensile test of concrete cylinders during splitting.

$$\text{Splitting tensile strength of concrete, } T = \frac{2P}{\pi DL}$$

Fig 2. Split Tensile Strength Testing

4.3. Flexural Strength

The bending test assesses the tensile strength of concrete in an not direct manner. An unreinforced concrete beam or slab is put to the test to see if it can survive bending failure. The fracture modulus, which is denoted as (MR) in MPa or psi, is the outcome of the concrete flexural test. The three point load test or the midpoint load test can be used to accomplish the concrete bending test. The tensile modulus obtained in the mid-load test is roughly 15% lower than that achieved in the three-point load test. Furthermore, it has been discovered that when a bigger sample of concrete is examined, a low fracture modulus is obtained.

Flexural Strength of concrete, MR = $\frac{3PL}{2bd^2}$

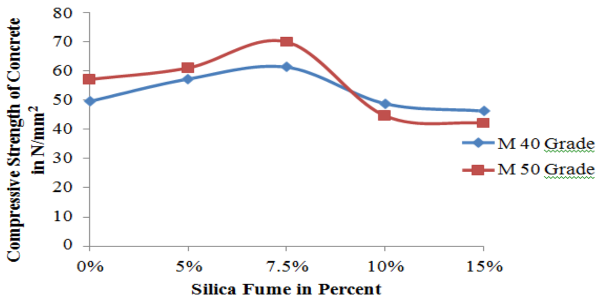
Fig 3. Flexural Strength Testing

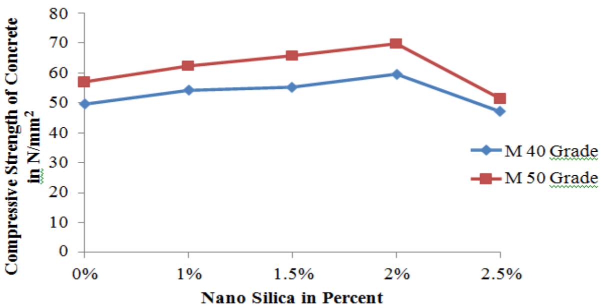
5. RESULTS AND DISCUSSION

For the current study, 3-samples were cast on average for each combination for 28 days. After 24 hours, the moulds be demolished and treated to water curing for each combination. The compressive, split tensile and flexural strength experiments was conceded out on samples, and the findings are listed below.

5.1. Compressive Strength Results

S.No	% Silica Fume	% Nano Silica	Compressive Strength(N/mm^2) M40 Grade	M50 Grade
1	0%	0	49.56	57.03
2	5%	0	57.18	61.00
3	7.5%	0	61.24	69.89
4	10%	0	48.74	44.58
5	15%	0	46.22	42.07
6	0	1%	54.11	62.26
7	0	1.5%	55.25	65.79
8	0	2%	59.61	69.72
9	0	2.5%	47	51.41
10	7.5	2%	62.35	71.5





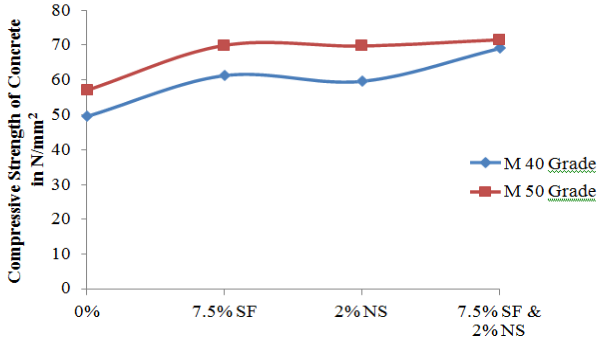
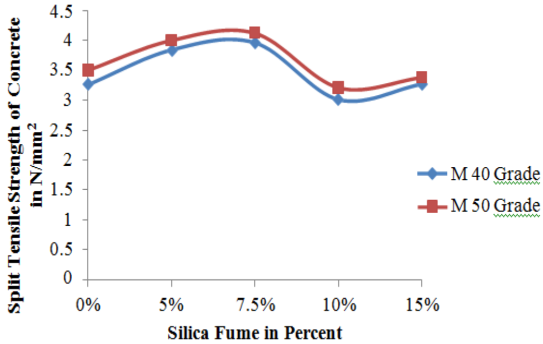
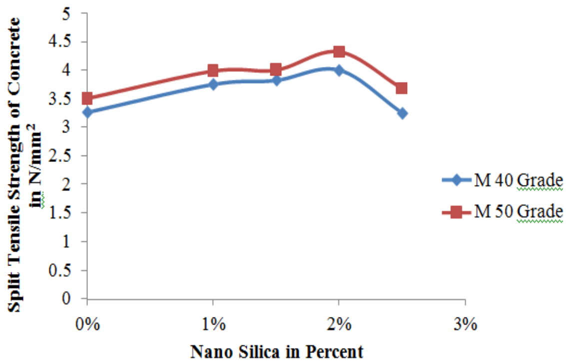


Table 7. Compressive strength at 28 days,
Graph 1. Compressive strength of Concrete with SF at 28 days,
Graph 2. Compressive strength of Concrete with NS at 28 days.
Graph 3. Comparision of compressive strength with Silica fumes and Nano Silica

5.2. Split Tensile Strength Results

SNO	% Silica Fume	% Nano Silica	Split Tensile Strength (N/mm^2) M40Grade	M50 Grade
1	0%	0	3.26	3.50
2	5%	0	3.84	4
3	7.5%	0	3.96	4.12
4	10%	0	3.01	3.21
5	15%	0	3.27	3.38
6	0	1%	3.74	3.98
7	0	1.5%	3.81	4
8	0	2%	4	4.32
9	0	2.5%	3.25	3.68
10	7.5	2%	4.1	4.38





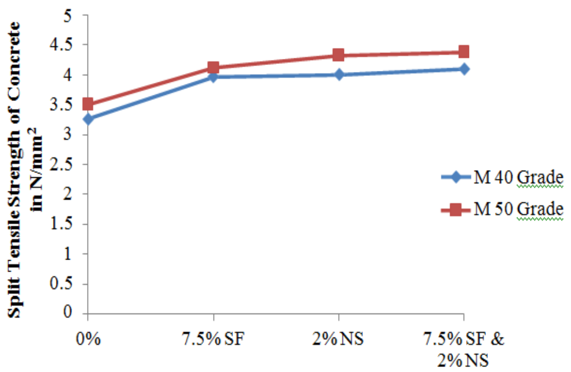
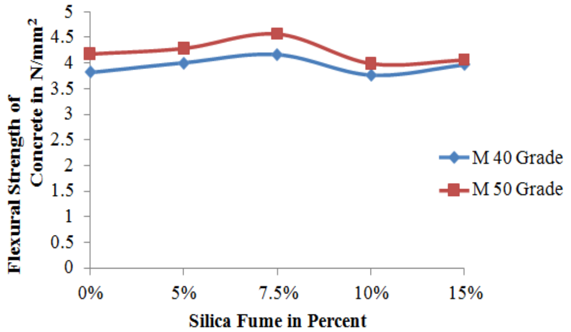
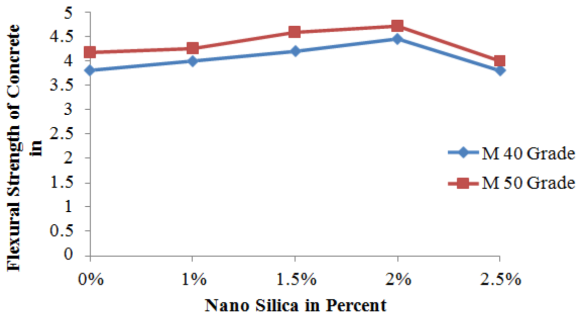


Table 8. Split tensile strength at 28 days,
Graph 4. Split tensile strength of concrete with SF at 28 days,
Graph 5. Split tensile strength of concrete with NS at 28 days.
Graph 6. Comparision of split tensile strength with SF and NS

5.3. Flexural Strength Results

SNO	% Silica Fume	% Nano Silica	Flexural Strength (N/mm^2)	
			M40 Grade	M50 Grade
1	0%	0	3.81	4.17
2	5%	0	4	4.28
3	7.5%	0	4.16	4.56
4	10%	0	3.76	3.98
5	15%	0	3.96	4.05
6	0	1%	4	4.25
7	0	1.5%	4.2	4.59
8	0	2%	4.45	4.71
9	0	2.5%	3.8	4
10	7.5	2%	4.53	4.84





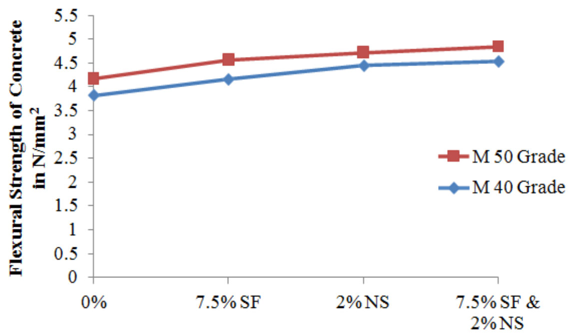


Table 9. Flexural Strength at 28 days,
Graph 7. Flexural Strength of Concrete with Silica fumes at 28 days,
Graph 8. Flexural Strength of Concrete with Nano silica at 28 days.
Graph 9. Comparision of flexural strength with Silica fumes and Nano Silica

6. CONCLUSIONS:

The subsequent conclusions are acquired based on investigational outcomes:

1. Compressive strength, split tensile strength, and flexural strength of the two M40 and M50 grades be gradually improved to substitution levels of 7.5 percent SF and 2 percent NS and subsequently dropped.
2. As the substitution of SF and NS in concrete increased, the workability of the two M40 and M50 grade concretes declined.
3. The utmost compressive strength, split tensile strength, and flexural strength of M40 grade concrete are 23.56%, 21.47%, and 9.18% higher than the standard M40 grade mix.
4. The maximum compressive strength, split tensile strength, and flexural strength of M40 grade concrete are 20.27%, 22.70%, and 16.80% higher than the standard M40 grade mix.
5. The maximum compressive strength, split tensile strength, and flexural strength of M50 grade concrete are 22.53%, 17.61%, and 9.35% higher than the standard M50 grade mix.
6. The maximum compressive strength, split tensile strength, and flexural strength of M50 grade concrete are 22.23%, 22.32%, and 12.94% higher than the standard M50 grade mix.
7. The percentage enhance in the compressive strength of concrete with the combination of 7.5% SF and 2% NS is 25.80% for grade M40 concrete and 25.35% for concrete of grade M50 grade higher than normal concrete of M40 and M50 grade respectively.
8. When in comparison to ordinary M40 and M50 grades, the percentage improvement in

split tensile strength of concrete with a mixture of SF at 7.5 percent and NS at 2 percent is 25.76% for M40 grade concrete and 25.03% for M50 grade concrete.

9. When in comparison to ordinary M40 and M50 grades, the percentage improvement in flexural strength with SF at 7.5 percent and NS at 2 percent is 18.89% for M40 grade concrete and 16.06% for M50 grade concrete.

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