EFFECT ON CONCRETE BY USING COLLOIDAL NANO-SILICA AS A PARTIAL REPLACEMENT OF CEMENT

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ABSTRACT

Concrete is most commonly used construction material and it consumes huge amount of cement. Manufacturing of process of cement produces CO_2 emission which is harmful to the environment. Method is to reduce cement content in concrete is use of nano-material as a partial replacement of cement in concrete.

One of the concrete that is becoming famous for it usage nowadays is nano-concrete and our experimental work deals with the fact that nano-material like nano-silica when added in optimized proportions to a standard M40 Grade concrete improves various properties. CNS nanoparticles with the average diameter of 5-40 nm were used with the five different contents of 1.5%, 3%, 4.5%, 6%, 7.5% by weight. The result showed that the use of CNS particles upto maximum replacement level of 3% and 4.5% produces concrete with improved strength. The workability of fresh concrete was decreased by increasing the content by CNS particles. Various tests like Compressive strength test, Flexural strength, Split tensile strength were carried out. It is concluded that partial replacement of cement with nano-phase CNS particles improves strength of concrete.

Keyword : - *Colloidal Nano silica, Compressive strength, Split tensile strength, Flexural strength.*

1. INTRODUCTION

Nanotechnology concerns with the use of materials of diamension approximately 1 to 100 nanometers. Encompassing nanoscale science, technology and engineering involves imaging, measuring, manipulating and modelling matter at this length scale. Nanotechnology is the study of the controlling of matter on an atomic and molecular scale. Nano-concrete is produced by incorporating nanomaterial into cement during mixing has established itself as a promising method, which encompasses the structure at the nanometer scale to develop multi-functional cementatious composites with superior durability and mechanical performance. Use of nanomaterial in concrete also possess very important properties like high ductility, self crack controlling ability, low electrical resistivity, self-sensing capabilities, self healing. It is apparent that the nanotechnology is efficient to bring several encouraging impact towards the development of high performance and sustainable construction materials, however process is enable to reduce CO_2 emission. In general, nano-material demonstrate considerable physical and chemical properties that differ from those of the conventional materials.

2. MATERIAL USED

2.1 Cement

The Ordinary Portland Cement of 53 Grade Birla Shakti cement conforming to IS :12269-1987.

Table-1: Properties of cement

Sr. No.	Characteristics	Values obtained
1	Normal Consistency	33 %
2	Initial Setting Time	52 min
3	Final Setting Time	285 min
4	Specific Gravity	3.11
5	Fineness	4.8

2.2 Fine aggregate

Fine aggregate is used for this study was local river sand conforming to IS: 383-1970.

Table-2: Properties of Fine Aggregate

Sr. No.	Characteristics	Value obtained
1	Type	Uncrushed
2	Specific Gravity	2.65
3	Total Water	0.65%
4	Fineness Modulus	2.5
5	Grading Zone	II

2.3 Coarse aggregate

Locally available coarse aggregate to conforming to IS: 383-1970.

Table-3: Properties of Coarse Aggregate

Sr. No.	Characteristics	Value obtained
1	Type	Crushed
2	Maximum size	20 mm
3	Specific Gravity	2.76
4	Water Absorption	0.995%

2.4 Colloidal Nano-Silica

Colloidal nano silica obtained from "Bee-Chem" Chemicals Ltd, Kanpur.

Table-4: Properties of Colloidal Nano silica

Sr. No.	Characteristics	Value obtained
1	Parameter	CemSynXTX
2	Active Nano content	30 – 32%
3	pH(20 ° C)	9 – 10
4	Specific Gravity	1.20 – 1.22
5	Particle Size	5– 40 nm

2.5 Water

Potable water confirming to IS: 456-2000 is used for casting and curing.

3. TESTS AND RESULTS

3.1 Compressive Strength Test

The compressive strength was performed using Compression Testing machine. The concrete specimens were cured in a water tank until they have reached the testing ages. Tests were performed on 150×150×150 mm specimens. Compressive strength for each mixture was obtained from an average of 3 cubic specimens determined at the age of 3, 7 and 28 days of curing.

Table-5: Results of Compressive Strength Test

Sr. No	CNS (%)	Compressive Strength (N/mm^2)		
		3 Days	7 Days	28 Days
1	0	22.18	33.71	48. 87
2	1.5	22.92	43.69	52.32
3	3	23.41	45.16	58.25
4	4.5	23.89	44.12	54.69
5	6	22.58	43.89	51.26
6	7.5	21.49	43.03	50.76

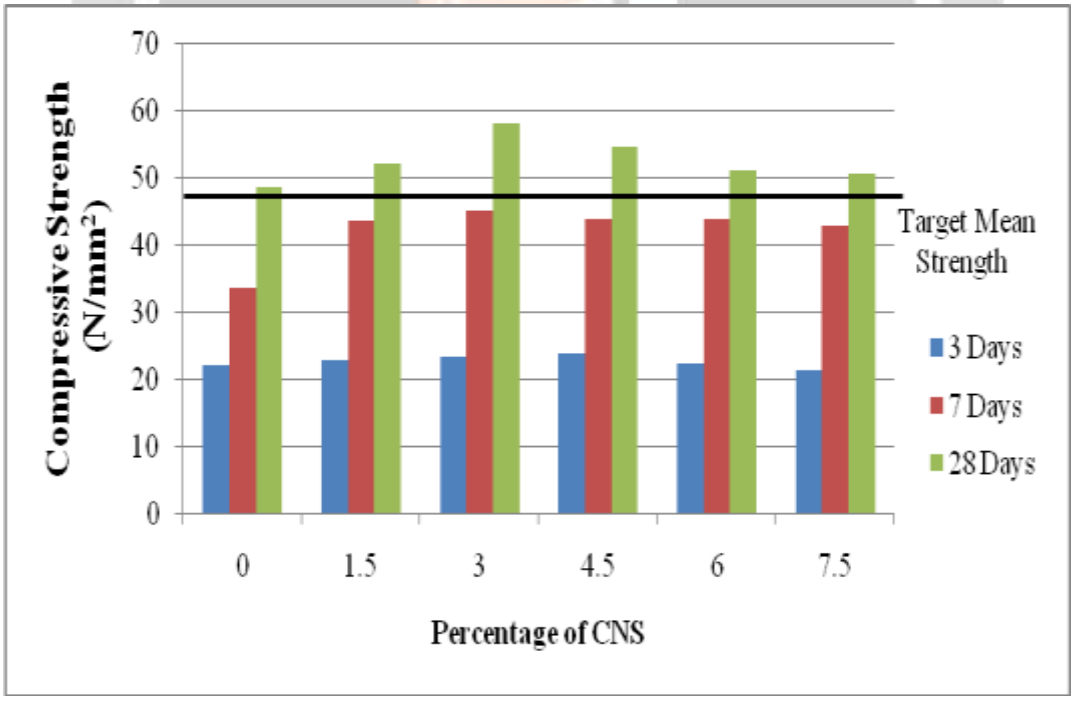

Chart -1: Compressive Strength of concrete for replacement of cement by Colloidal Nano-silica

3.2 Split Tensile Strength Test

For determining split tensile strength, cylinder specimens of size 150mm in diameter & 300mm in length are placed between the two plates of Compression Testing Machine. The load is applied at a uniform rate till the specimen failed by a fracture along vertical diameter. The failure load is noted and split tensile strength is calculated.

Table-6: Results of Split tensile Strength Test

Sr. No	Replacement of cement by CNS (%)	Split tensile strength (N/mm^2)
1	0	4.57
2	1.5	5.21
3	3	5.97
4	4.5	5.36
5	6	4.92
6	7.5	4.71

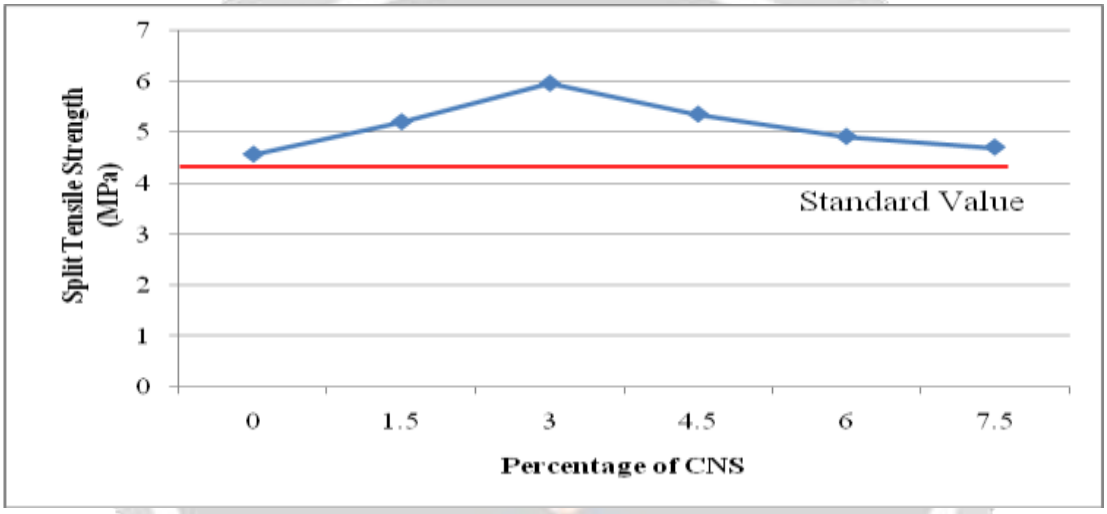

Chart-2: Split tensile strength of concrete for replacement of cement by Colloidal Nano-silica after 28 Days

3.3 Flexural Strength Test

To know flexural strength of nano-silica based concrete, beam size 100 X 100 X 500 mm are casted . After 28 days of curing specimens were tested for flexure.

Table-7: Results of Flexural Strength Test

Sr. No	Replacement of cement by CNS (%)	Flexural strength (N/mm^2)
1	0	5.80
2	1.5	6.12
3	3	6.47
4	4.5	8.04
5	6	7.45
6	7.5	7.09

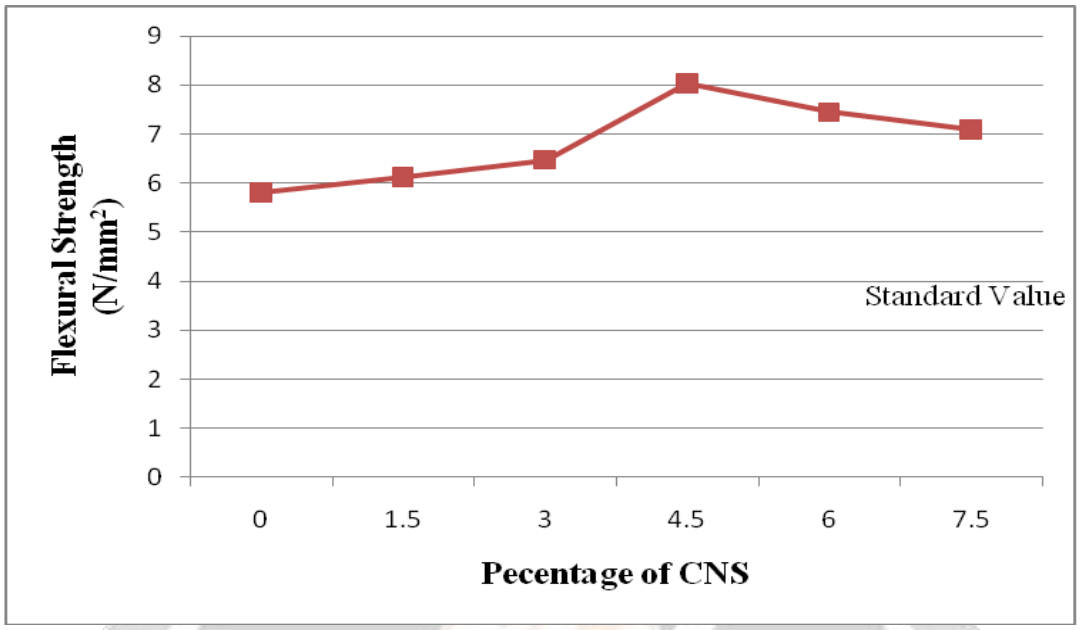

Chart-3: Flexural strength of concrete for replacement of cement by Colloidal Nano-silica after 28 Days

4. CONCLUSIONS

- Compressive strength was found 7.06%, 19.19%, 11.91%, 4.89%, 3.87% more than that of conventional concrete when cement is replaced by 1.5%, 3%, 4.5%, 6%, 7.5% CNS respectively for the age of concrete 28 days. 3% replacement of cement by CNS gives maximum compressive strength.
- Split Tensile strength was found 13.34%, 25.82%, 11.44%, 10.05%, 6.56% more than that of conventional concrete when cement is replaced by 1.5%, 3%, 4.5%, 6% , 7.5% CNS respectively at the age of concrete 28 days.
- Flexural strength of concrete was found 5.52%, 11.55%, 38.62%, 28.44%, 22.24% more than that of conventional concrete for the replacement of 1.5%, 3%, 4.5%, 6%, 7.5% Nano-silica respectively at the age of concrete 28 days.
- Colloidal Nano-silica based concrete gives more strength than conventional concrete.

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