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Effect of Nano Silica on Mechanical Properties of High Strength Concrete of M60 Grade

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Abstract*— In the present study High Strength Concrete of M60 grade was designed by using Cement, Fly ash, Fine Aggregate, Coarse Aggregate, Water and Super Plasticizer following IS 10262-2009 and IS 456-2000. In the above mix cement was replaced partially with Nano Silica by varying percentages by weight (1%, 2%, 3% and 4%) and the effect of nano silica on the strength behaviour was studies. The Compressive, Flexural and Tensile strengths of the concrete were determined at 7, 14, 28 and 56 days and the results were compared.

Keywords*— High strength concrete, Fly ash, Nano silica, Compressive strength, Flexural strength, Tensile strength

I. INTRODUCTION

High strength concrete is obtained with low water to binder ratio. Along with low water binder ratio mineral admixtures improve the packing density by filling the void space between the aggregates. Nano technology is making of materials which are less than 100 nano meters. Nano materials are very effective in changing properties of concrete at ultrafine level because of its small size. Nano materials are well practiced and successively applied in the field of material science. Nano materials when used in concrete not only improve quality and durability but also to overcome traditional problems in concrete. The packing density of the mix can be further improved by including these nano materials. In the study nano silica obtained from Nano Research India Lab was used to develop high strength concrete along with cement and fly ash. Size of the particles was 30-50 nano meters in diameter. Its morphology was spherical and density was 2.5g/cm^3.

II. LITERATURE REVIEW

Mohamed Amin and Khaled Abu el-hassan[1] in their study evaluated the effect of addition of nano silica, nano Cu-Zn ferrite, nano Ni ferrite to concrete. Conventional concrete mixes were replaced by nano silica, nano Ni ferrite, nano Cu-Zn ferrite by weight percentage of cement by 1%, 2%, 3%, 4%, 5%, 6% and the optimum dosages of 3%, 2% and 2% was obtained. Gengying Li[2] in his paper experimented on high-volume fly ash incorporating nano SiO_2 in high strength concrete, Portland concrete and high-volume fly ash high strength concrete.PCC, SHFAC, PCC. He concluded that addition of nano SiO_2 to high volume fly ash increases both short term & long-term compressive strength. Anwar m. mohamed[3] experimented on the effect of nano material on mechanical properties of concrete at different percentage. Nano silica and nano clay were used together along with cement and had remarkable improvement on compressive strength and tensile strength. Zemeni wu, caijun shi, k.h khayat, shu wan[4] studied the effect of nano calcium carbonate and nano silica on flow ability, heat of hydration, mechanical properties and pore structure of ultra-high strength concrete. Both nano $CaCO_3$ and nano SiO_2 decreased the flowability and increased the heat of hydration of ultra-high strength concrete. The optimal dosage for nano $CaCO_3$ was in the range of 1.6% - 4.8% and nano $SiO_2$was in the range of 0.5-1.5%. From the literature review as nano SiO_2 showed improvement , it was used for designing M60 grade concrete as per Indian guidelines.

III. EXPERIMENTAL INVESTIGATION

Ordinary Portland cement of 53 Grade manufactured by Coromandel King Cement was used for the experiments. Tests were conducted on cement according to IS 4031 and results were compared as per IS : 12269-2013. River sand confirming to Zone II was used as fine aggregate and Coarse aggregate of 20mm nominal size conforming to IS: 383-1970 obtained from Gandipet Quarry plant was used. As the addition of mineral admixtures results in increase in workability, reduces alkali aggregate reaction, reduces thermal shrinkage and reduces the cost, fly ash of specific gravity 2.25 was used. Super plasticizers BASF Master Glenium sky 8630 was used to improve the workability of concrete. A simplified mix design was formulated by combining both IS codes and ACI codes and Rational mix method was followed to obtain M60 grade concrete. M60 grade concrete with water binder ratio of 0.29 with fly ash as partial replacement of cement by 11% was obtained. Later nano silica was added at varying dosages as 1%, 2%,3%,4% and 5% in fly ash concrete of M60 grade. The dosage of Super plasticizer was adjusted to obtain the required workability. Compressive, Split tensile strength and Flexural strength was studied on the cube, cylinder and prisms at 7days, 14 days and 28 days and the results were compared. Compressive strength was determined on cube specimen of 150mm x150mm by testing in a compressive testing machine at the rate of 140kg/cm/min. Tensile strength which greatly affect the extent and size of Structures was obtained by testing cylinders of 150mmx 300mm at a loading rate of

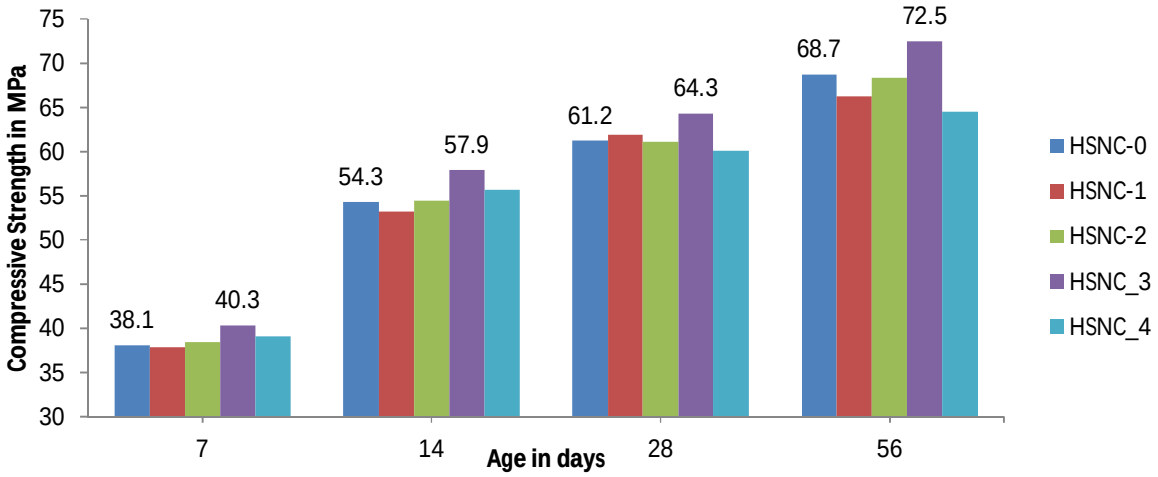
0.7kg/cm^2/min. Flexural strength was conducted on prisms of 150mm x 150mm x 700 mm specimens by applying a two point load in an Universal Testing Machine.

IV. RESULTS

In the achieved mix design cement was replaced with nano silica by 1%, 2%, 3% and 4% by weight. Each mix was checked for required workability and specimens were cast and tested for compressive strength, split tensile strength and flexural strength after curing in normal water for 7,14,28 and 56 days. The test results were tabulated in the Table: 1, Table: 2 and Table: 3.

Table:1 Effect of nano silica on Compressive strength on M60 grade concrete

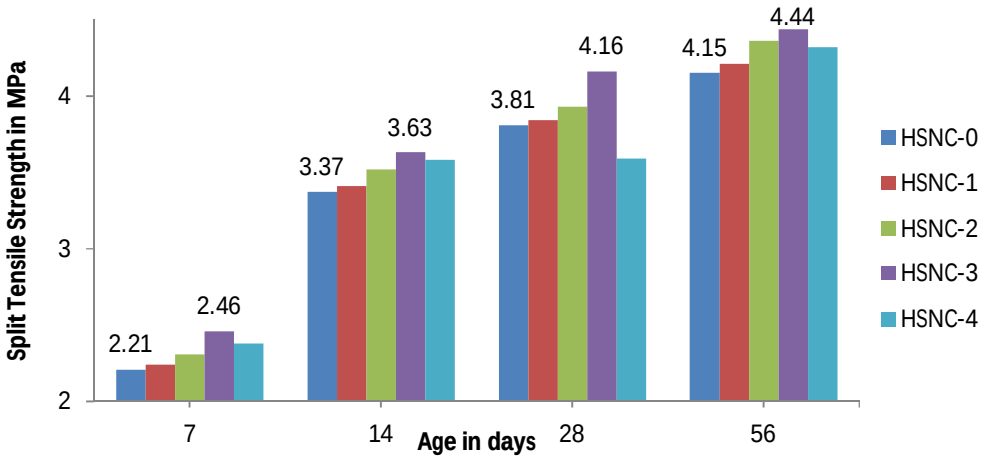
MIX	% of nano silica	Compressive strength (MPa)			
		7days	14days	28 days	56 days
HSNC-0	0	38.1	54.3	61.2	68.7
HSNC-1	1	37.9	53.2	61.9	66.3
HSNC-2	2	38.4	54.4	62.1	68.4
HSNC-3	3	40.3	57.9	64.3	72.5
HSNC-4	4	39.1	55.7	60.1	64.5



Graph:1 Compressive strength vs Age for mixes with different % of nano silica

Table: 2 Effect of nano silica on Split Tensile strength on M60 grade concrete

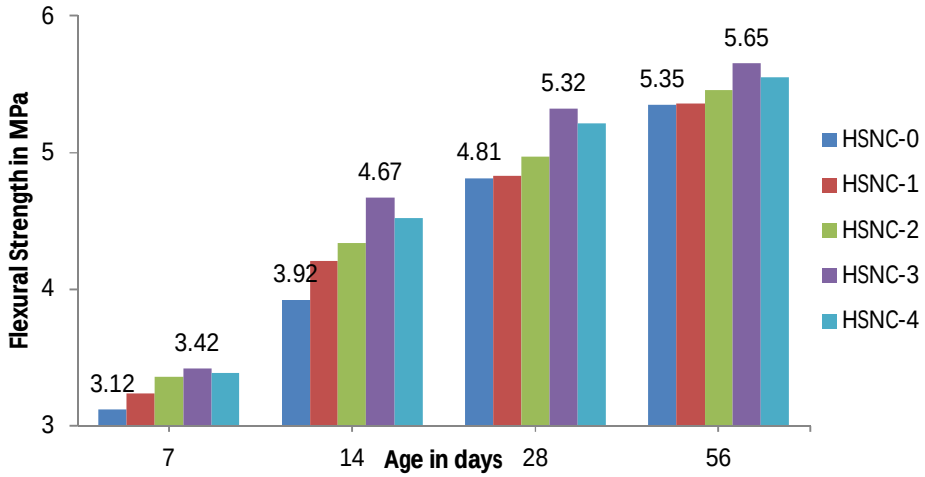
MIX	% of nano silica	Split Tensile strength (Mpa)			
		7days	14days	28 days	56 days
HSNC-0	0	2.21	3.37	*3.81*	*4.15*
HSNC-1	1	2.24	3.41	*3.84*	*4.21*
HSNC-2	2	2.31	3.52	3.93	4.36
HSNC-3	3	2.46	3.63	*4.16*	*4.44*
HSNC-4	4	2.38	3.58	3.59	4.32



Graph:2 Split Tensile strength vs Age for mixes with different % of nano silica

Table:3 Effect of nano silica on Flexural strength on M60 grade concrete

MIX	% of nano silica	Flexural strength (Mpa)			
		7days	14days	28 days	56 days
HSNC-0	0	3.12	3.92	4.81	5.35
HSNC-1	1	3.24	4.21	4.83	5.36
HSNC-2	2	3.36	4.34	4.97	5.46
HSNC-3	3	3.42	4.67	5.32	5.65
SNC-4	4	3.39	4.52	5.21	5.55



Graph: 3 Flexural strength vs Age for mixes with different % of nano silica

From the Graph:1 , Graph:2 and Graph: 3, it was observed that addition of nano silica in M60 grade concrete improved the mechanical strength of the concrete at 3% partial replacement of cement with nano silica and 11% partial replacement of cement

with fly ash. This is because of increased packing density and also because of the additional hydration products formed with the addition of nano silica and fly ash.

From the Graph:1 , Graph:2 and Graph: 3, it was observed that there was substantial increase in compressive strength, Split tensile strength and flexural strength with the increase in age of concrete.

From the Graph: 1 it was observed that at 3% partial replacement of cement , the compressive strength of concrete were 40.3MPa, 57.9MPa,64.3 MPa and 72.5 MPa at 7 days, 14 days, 28 days and 56 days respectively and without addition of nano silica the compressive strengths were 38.1MPa, 54.3MPa,61.2 MPa and 68.7 MPa at 7 days,14 days, 28days and 56 days respectively.

From the Graph: 2 it was observed that at 3% partial replacement of cement, the Spilt Tensile strength of concrete were 2.46MPa, 3.63MPa,4.16 MPa and 4.44MPa at 7 days, 14 days, 28 days and 56 days respectively and without addition of nano silica the Split tensile strengths were 2.211MPa, 3.37MPa,3.81 MPa and 4.15 MPa at 7 days,14days, 28 days and 56 days respectively.

From the Graph:3 it was observed that at 3% partial replacement of cement , the Flexural strength of concrete were 3.42MPa, 4.67MPa,5.32MPa and 5.65MPa at 7 days, 14days, 28days and 56 days respectively and without addition of nano silica the Flexural strengths were 3.12MPa, 3.92MPa,4.81MPa and 5.35MPa at 7 days,14 days, 28 days and 56 days respectively.

V. CONCLUSIONS

A. It can be concluded by rational method of mix design, High strength M60 grade concrete can be designed by addition of 11% of fly ash and 3% of nano silica as partial replacement of cement.

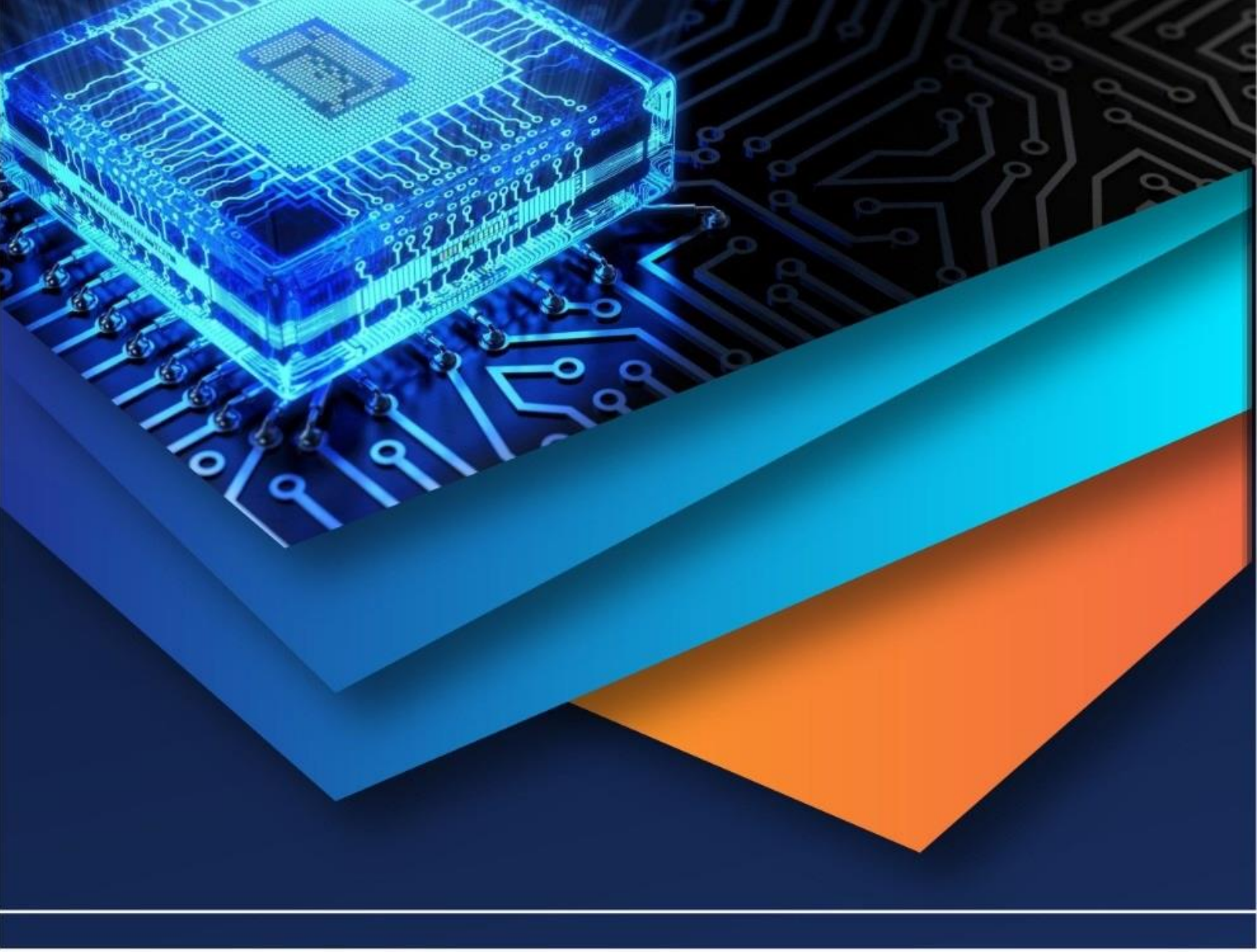
B. The mix showed 5.77 %, 6.62 %, 5.06 % and 5.53 % improvement in compressive strengths at 7 days,14 days ,28 days and 56 days respectively.

C. The Split tensile strengths showed 11.26 %, 7.71 % , 9.18 % and 6.98 % improvement at 7 days,14 days ,28 days and 56 days respectively.

D. The Flexural strengths showed 9.61 %, 19.13 % , 10.6 % and 5.61 % improvement at 7 days,14 days ,28 days and 56 days respectively.

REFERENCES

[1] Amin, M., & Abu el-Hassan, K. (2015). Effect of using different types of nano materials on mechanical properties of high strength concrete. Construction and Building Materials, 80, 116-124
[2] Li, G. (2004). Properties of high-volume fly ash concrete incorporating nano-SiO2. Cement and Concrete research, 34(6), 1043-1049.
[3] Mohamed, A. M. (2016). Influence of nano materials on flexural behavior and compressive strength of concrete. HBRC journal, 12(2), 212-225.
[4] Wu, Z., Shi, C., Khayat, K. H., & Wan, S. (2016). Effects of different nanomaterials on hardening and performance of ultra-high strength concrete (UHSC). Cement and Concrete Composites, 70, 24-34
[5] Haque, M. N., & Kayali, O. (1998). Properties of high-strength concrete using a fine fly ash. Cement and Concrete Research, 28(10), 1445-1452
[6] Nasution, A., Imran, I., & Abdullah, M. (2015). Improvement of concrete durability by nanomaterials. Procedia Engineering, 125, 608-612.
[7] IS 12269: 2013. (2013). Indian standard ordinary Portland Cement, 53 Grade–Specification.
[8] Standard, I. (1988). IS-4031-1988.—. Methods Of Physical Tests For. Hydraulic Cement, Bureau of Indian Standards, Manak Bhawan, 9.
[9] BIS, I. (1970). 383 (1970) Specification for Coarse and Fine Aggregates from Natural Sources for Concrete. Bureau of Indian Standards, New Delhi, India.
[10] Standard, I. (1999). Splitting tensile strength of concrete-method of test.
[11] Mix proportioning guidelines IS 10262- 2009.
[12] Committee211, A. C. I. (1998). Guide for selecting proportions for high-strength concrete with portland cement & fly ash-ACI 211.4 R-93. Farming-ton Hills, Michigan: American Concrete Institute.
[13] IS: 516. (1959). Indian standard methods of tests for strength of concrete. Bureau of Indian Standards.



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