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An Experimental Study on Mechanical Properties of Nano Concrete

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ABSTRACT
Nano Materials Are The Advanced Pozzolana To Improve The Microstructure And Stability Of Cement Based System. This Paper Highlights The Effect Of Addition Of Nano Materials On The Mechanical Properties Of Concrete. To Compare The Different Nano Materials Two Nano Materials Were Taken Along With Polypropylene Fibre. Nano Silica And Nano Alumina Were Taken As 1%, 2%, 3%, 4% And 5% Of Cementatious Material. Mechanical Tests Such As Compression Test, Indirect Tensile Test And Flexure Test Were Performed To Find Mechanical Properties. Results Shows Improvement In Compression, Tensile And Flexural Strength For All Material Up To Optimum Limit.
Keywords – Nano Meterial, Concrete, Polypropylene Fiber.

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I. INTRODUCTION

Concrete Is The Most Widely Used Construction Materials In The World Due To Its Low Cost And Good Durability. Nanotechnology Is Based On Synthesizing Nano-Particles With Specified Characteristics To Be Used In Different Applications Related To The Industry, Medicine, Agriculture, Etc. A Nano-Particle Is A Microscopic Particle Whose Size Is Measured In Nano-Meters (Nm). High Strength Concrete (HSC) Modified With Nano-Silica (NS) Increases Residual Compressive And Tensile Strengths, And Spalling And Mass Loss Are Decreased As Penetrability Increased At Elevated Temperature [1]. Nano-Sio_2 And Pozzolan Simultaneously Leads To Improved Compressive Strength And A Reduced Water Absorption Capacity.

II. THEORETICAL WORK

The Objective Of The Present Work Is To Develop Concrete With High Strength, Less Porous, Less Capillarity So That Durability Will Be Reached Up To A Certain Extent. For This Purpose, It Requires The Use Of Different Pozzolanic Materials Like Nano Silica And Nano Alumina. So The An Experimental Programme To Be Undertaken Was Planned To Carry Our Various Tests And Were Aimed On The Followings;

- To Determine The Mix Proportion With Nano Silica And Nano Alumina To Achieve The Desire Needs.
- To Investigate Different Basic Properties Of Concrete Such As Compressive Strength, Splitting Tensile Strength, Flexural Strength Etc And Comparing The Results Of Different Proportioning.

To Compare The Different Nano Materials Total Two Nano Materials Were Taken. Nano Silica And Nano Alumina Were Taken As 1%, 2%, 3%, 4% And 5% Of Cementatious Material.

Total 9 Cubes Were Casted Of Each Concrete Type And For Each Proportion. The Compressive Test Was Then Performed On Each Concrete Cube At 7 Days, 14 Days And 28 Days Of Casting. Total 3 Beams And 3 Cylinders Were Casted For Split Tensile Test And Flexural Test Accordingly.

For Compression Test Of Concrete Cubes Were Prepared For Each Mix With Dimension 15cm×15cm×15cm According To IS:516-1959. Three Cubes Were Prepared For Each Test Day And For Each Mix. Cubes Were Tested At 7, 14 And 28 Days. Indirect Tensile Test Specimens Were Prepared For Each Mix Having Cylindrical Shape With Dimension 15cm Dia × 30 Cm Length According To IS:5816-1999. Cylinders Were Tested At 28 Days For Tensile Strength. For Flexure Beams Were Prepared For All Mix Having Dimensions 10cm×10cm Cross Section With 50cm Length According To IS:516-1959.

TABLE 1 MIX PROPORTION FOR M60

Mix No	Cement	Micrifine	Nano Silica	Nano Alumina	Sand	Coarse Aggregate		Water	Chemical Admixture
						10mm	20mm		
PC	436.6	48.5	0.00	0.00	713.4	617	617	135.8	2.9
NS1	432.23	48.5	4.37	0.00	713.4	617	617	135.8	-
NS2	427.87	48.5	8.73	0.00	713.4	617	617	135.8	-
NS3	423.50	48.5	13.10	0.00	713.4	617	617	135.8	-
NS4	419.14	48.5	17.46	0.00	713.4	617	617	135.8	-
NS5	414.77	48.5	21.83	0.00	713.4	617	617	135.8	-
NA1	432.23	48.5	0.00	4.37	713.4	617	617	135.8	-
NA2	427.87	48.5	0.00	8.73	713.4	617	617	135.8	-
NA3	423.50	48.5	0.00	13.10	713.4	617	617	135.8	-
NA4	419.14	48.5	0.00	17.46	713.4	617	617	135.8	-
NA5	414.77	48.5	0.00	21.83	713.4	617	617	135.8	-

TABLE 2 MIX PROPORTION FOR M80

Mix No	Cement	Micrifine	Nano Silica	Nano Alumina	Sand	Coarse Aggregate	Water	Chemical Admixture
						10mm		
PC	450.00	50.0	0.00	0.00	744.3	1192.6	130	2
NS1	432.10	50.0	4.50	0.00	744.3	1192.6	130	-
NS2	427.60	50.0	9.00	0.00	744.3	1192.6	130	-
NS3	423.10	50.0	13.50	0.00	744.3	1192.6	130	-
NS4	418.60	50.0	18.00	0.00	744.3	1192.6	130	-
NS5	414.10	50.0	22.50	0.00	744.3	1192.6	130	-
NA1	432.10	50.0	0.00	4.50	744.3	1192.6	130	-
NA2	427.60	50.0	0.00	9.00	744.3	1192.6	130	-
NA3	423.10	50.0	0.00	13.50	744.3	1192.6	130	-
NA4	418.60	50.0	0.00	18.00	744.3	1192.6	130	-
NA5	414.10	50.0	0.00	22.50	744.3	1192.6	130	-

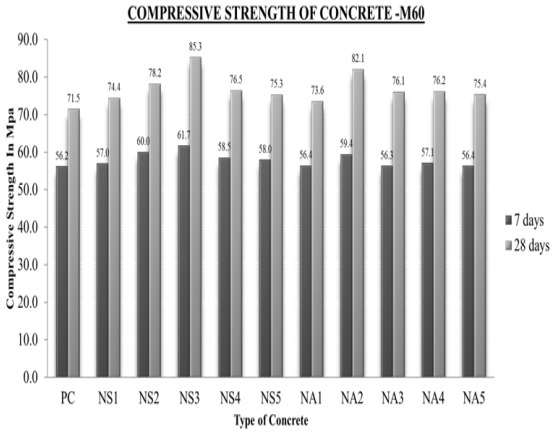
Calculation Based On Peak Load For Indirect Tensile Strength And Flexure Strength Were Done With Following Equation Below.

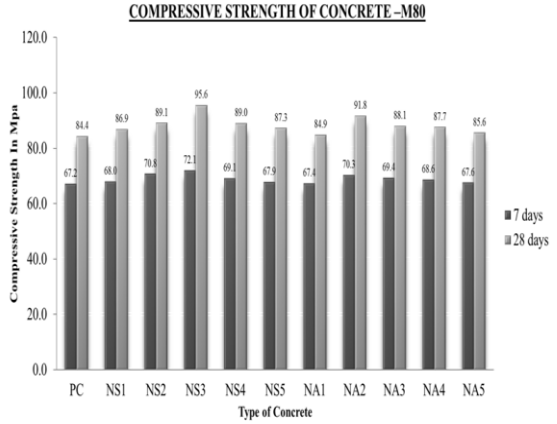
$$f_{ct} = \frac{2P}{\pi ld}$$

$$f_b = \frac{p \times l}{b \times d^2}$$

III. RESULT AND DISCUSSION

3.1 Compressive Strength





Compressive Strength Of Nano Concrete At 7 And 28 Days Are Shown In FIG. 1. The Values Are Average Of 3 Cube Strength At Each Testing Day. It Can Be Found That The Compressive Strength Of Nano Concrete Increases In Almost All Cases As Compared To Ordinary Concrete.

Concrete Containing Nano Silica Increases The Strength Up To 9.81% And 19.30% For 7 Days And 28 Days Respectively In M60 And 7.23% And 13.23% For 7 Days And 28 Days Respectively In M80. The Reason For Increased Strength Is Pozzolanic Reaction Of Nano Silica. Nano Materials Reacts With Calcium Hydroxide $Ca(OH)_2$ Crystals Which Forms C-S-H Gel. Nano Materials Also Act As A Filler Of Voids In Concrete Which Makes Concrete Denser. It Can Be Seen From The FIG 1 And 2 That The Optimum Dose Of Nano Silica In Concrete Is 3% By Weight Of All Cementitious Materials As Results Beyond 3% Decreases With Further Increase In Nano Silica Content. Decrease In Strength May Be Due To Increase In Week Zone Zones In Concrete With Increased Nano Silica Content As It Imparts Negative Effects On Hydration Process. Nano Alumina Also Shows Same Behavior As Nano Silica With Maximum Dosage Of Nano Alumina Found As 2%.

3.2 Tensile Strength

Table 3 And 4 Shows Values Of Tensile Strength For Nano Concrete With All Mixes And Result Increases In All Cases. Addition Of Nano Silica And Alumina Also Contribute Towards The Tensile Strength As Can Be Seen From The Results And Maximum Percentage Increase Can Be Seen In 3% Nano Silica And 3% Nano Alumina Which Are 38.34 And 19.25 Respectively For M60. In Case Of M80 Maximum Percentage Increase Can Be Seen In 3% Nano Silica And 2% Nano Alumina Which Are 20.36 And 13.26 Respectively.

TABLE 3 TENSILE STRENGTH IN M60

Mix	Tensile Strength In Mpa	
	F_{ct}	Enhanced Extent (%)
PC	2.23	0.00
NS1	2.30	2.98
NS2	2.50	11.72
NS3	3.09	38.34
NS4	2.41	7.92
NS5	2.31	3.42
NA1	2.31	3.62
NA2	2.59	15.87
NA3	2.66	19.25
NA4	2.66	18.98
NA5	2.44	9.45

TABLE 4 TENSILE STRENGTH IN M80

Mix	Tensile Strength In Mpa	
	Fc	Enhanced Extent (%)
PC	4.16	0.00
NS1	4.26	2.32
NS2	4.52	8.63
NS3	5.01	20.36
NS4	4.39	5.45
NS5	4.27	2.66
NA1	4.25	2.28
NA2	4.71	13.26
NA3	4.67	12.21
NA4	4.58	10.11
NA5	4.46	7.31

3.3 Flexural Strength

Flexural Test Results Of All Specimens At 28 Days Are Shown Inn Table 5 And 6 Results Show Same Behavior Of Nano Material In Flexure As In Compression. Nano Silica And Nano Alumina Shows Same Optimum Dosage Of 3% And 2% Respectively For Flexure As Well.

TABLE 5 FLEXURAL STRENGTH-M60

Mix	Tensile Strength In Mpa	
	Fb	Enhanced Extent (%)
PC	4.66	0.00
NS1	5.58	19.85
NS2	5.74	23.28
NS3	6.20	33.21
NS4	4.76	2.29
NS5	4.32	-7.18
NA1	4.74	1.82
NA2	5.35	14.89
NA3	5.19	11.34
NA4	5.02	7.87
NA5	5.02	7.82

TABLE 6 FLEXURAL STRENGTH-M80

Mix	Tensile Strength In Mpa	
	Fb	Enhanced Extent (%)
PC	8.12	0.00
NS1	9.37	15.35
NS2	9.60	18.21
NS3	9.69	19.26
NS4	8.63	6.23
NS5	8.21	1.01
NA1	8.36	2.84
NA2	9.11	12.12
NA3	8.99	10.60
NA4	8.63	6.20
NA5	8.30	2.10

IV. CONCLUSION

1. Content Of Nano Silica Increases Compressive, Tensile And Flexural Strength Up To 3% By Weight Of Cementitious Material And After Further Addition Strength Decreases Which Gives Optimum Dosage Of Nano Silica As 3%.
2. Nano Alumina Exhibits Better Compression, Tensile And Flexural Behavior As Compare To Ordinary Concrete, But Takes A Back Step As Comparison With Other Nano Material Studied. The Optimum Dosage Found Out To Be 2% For Nano Alumina.

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