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Effect of Nano Silica on Durability Parameters of High Strength Concrete

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Abstract: ***High strength concrete is a term used to describe concrete with special properties not attributed to normal concrete. High-performance means that the concrete has one or more of the following properties: low shrinkage, low permeability, a high modulus of elasticity, or high strength. The application of nanotechnology in concrete has added a new dimension to the efforts to improve properties of High strength concrete. Nano materials, by virtue of their very small particle size can affect the concrete properties by altering the microstructure. Concrete can deteriorate for a variety of reasons, and concrete damage is often as result of combination of factors. This causes stresses in the concrete, which can eventually have resulted in cracking, delamination, and spalling. Concrete resists weathering action, chemical attack, and abrasion while maintaining its desired engineering properties throughout its lifespan. Different concretes require different degrees of durability depending on the exposure of environment and the properties desired. Durable concrete will retain its original form, quality and serviceability when exposed to its environment. The main characteristics influencing the durability of concrete is its permeability to the ingress of water, oxygen, carbon dioxide, chloride, sulphate and other deleterious substances. It became necessary to impart knowledge about durability of concrete and factors affecting durability to the society, as the wide use of concrete as a material in the constructions. This study concerns with the use of Nano silica of size 12 nm in M60 grade of concrete to improve the compressive strength of concrete and study on various durability parameters of High strength concrete. An experimental investigation is planned to carry out with different amount of Nano silica in concrete as 0%, 0.1%, 0.2%, 0.3% and 0.4% by weight of concrete. For the study the tests have been planned to carry out are workability, compressive test, flexural test, split tensile test. To study durability parameters of High strength concrete with nano silica Rapid chloride penetration test (RCPT), Water Sorptivity test, Acid attack test, Sulphate attack test and Oxygen permeability test are conduct.***
Keywords: Nano silica, High strength concrete, durability parameters.

I. INTRODUCTION

High-performance concrete is a term used to describe concrete with special properties not attributed to normal concrete. High-performance means that the concrete has one or more of the following properties: low shrinkage, low permeability, a high modulus of elasticity, or high strength. According to Henry Russell, ACI defines high performance concrete as "concrete that meets special performance and uniformity requirements that cannot always be achieved routinely by using only conventional materials and normal mixing, placing, and curing practices.

The requirements may involve enhancements of placement and compaction without segregation, long-term mechanical properties, early-age strength, toughness, volume stability, or service life in severe environments". High-strength concrete is typically recognized as concrete with a 28-day cylinder compressive strength greater than 6000 psi or 42 Mpa. More generally, concrete with a uniaxial compressive strength greater than that typically obtained in a given geographical region is considered high-strength, although the preceding values are widely recognized. Strengths of up to 20,000 psi (140 Mpa) have been used in different applications.

Laboratories have produced strengths approaching 60,000 psi (480 Mpa). Durability of concrete is its ability to resist weathering action, chemical attack, abrasion or any other process of deterioration. The ability of concrete to withstand the conditions for which it is designed without deterioration for a long period of years is known as durability.

II. LITERATURE REVIEW

The review of a number of literatures shows the importance of this field of research. The findings show that a number of nanomaterials like SiO2, TiO2, Al2O3, colloidal nanosilica, metakaolin and others can be incorporated to improve the properties of concrete. The results show the improved characteristics of the blended concrete in terms of compressive, tensile and flexural strength & durability parameters as well. The approach is an integrated one in that it links durability index parameters, and

performance specifications. The current study is concerned with the incorporation of Nano Silica in high strength concrete with different percentage and conducts workability test, compressive test, flexural test, tensile test and various durability tests like Rapid chloride penetration test (RCPT), Water Sorptivity index, Acid attack test, Sulphate attack test and Oxygen permeability tests.

III. OBJECTIVES OF WORK

A. To study effect of Nano silica on strength and durability parameters of high strength concrete.
B. To study durability Indices of high strength concrete with use of Nano silica.

IV. SCOPE OF WORK

A. The study is aimed to prepare various concrete mix with high strength (M60) with various amount of Nano Silica as an ingredient and then to perform durability tests for assessing durability indices.

B. Work flow defined is as under
1) Prepare M60 concrete mixes with various Nano silica content
2) Conduct durability tests
a) Rapid Chloride Permeability Test
b) Water Sorptivity Tes
c) Acid attack tes
d) Sulphate attack test
e) Oxygen permeability test
3) Conduct strength tests
a) Compressive strength test
b) Flexural strength test
c) Tensile strength test

C. Analysis of results and reporting the outcomes.

V. MATERIALS

Concrete is mixture of cement, fine aggregate, coarse aggregate, water and admixtures (if required). Here in this study high strength concrete is used so, M60 grade of concrete is used for this study. Also nano silica is also added in this concrete with different volume (0%, 0.1%, 0.2%, 0.3% and 0.4%) for better strength and carries out the tests for its strength and durability.

VI. METHODOLOGY

A. Mix Design

As per IS 10262 prepare a mix design of M60 and M65 grade of concrete. In this MIX design fibres, Nano silicaare added in different percentage. Table no. I and II show the mix design of M60 and M65 grade of concrete.

TABLE I MIX DESIGN OF M60 GRADE OF CONCRETE

Cement	Water	Super plasticizer	Sand	Coarse aggregate	Density
443.6 Kg/m^3	177.44 Kg/m^3	2.21 Kg/m^3	659.48 Kg/m^3	1259.57 Kg/m^3	2542.3 Kg/m^3
1	0.4	0.00498	1.48	2.83	-

TABLE III MIX DESIGN OF M65 GRADE OF CONCRETE

Cement	Water	Super plasticizer	Sand	Coarse aggregate	Density
506.97 Kg/m^3	177.44 Kg/m^3	2.53 Kg/m^3	639.14 Kg/m^3	1220.73 Kg/m^3	2546.81 Kg/m^3
1	0.35	0.00499	1.26	2.21	-

B. Mixing And Casting

Hand mixing is adopted for mixing of the basic materials of concrete and mixed concrete is moulded into cube, cylinders and beam for different tests.

Image 1 mixing of concrete


C. Curing

After casting work is over moulded specimens are stored in room temperature for 24 hours. After this period specimens are taken out from mould carefully without damaging the surface and immersed in water for 28 days.

D. Testing

The specimen cured as stated above tested according to IS 516: 1959 code standards and ASTM C1202, ASTM C 1585 – 04. The entire strength tests were done accordingly IS 516: 1959 and other tests of Durability were done accordingly ASTM C1202 and ASTM C 1585 – 04. The results mentioned were average of the values obtained from three specimens.

Image II testing of concrete specimen



VII. RESULTS AND DISCUSSION

A. Slump Test

TABLE IIIII RESULTS OF SLUMP TEST

Sr. No.	Name of sample	Grade of concrete	% Nano silica	Slump value (mm)
1	M1-NS0	M60	0.0%	95
2	M1-NS1	M60	0.1%	98
3	M1NS2	M60	0.2%	103
4	M1-NS3	M60	0.3%	105
5	M1-NS4	M60	0.4%	108
6	M2-NS0	M65	0.0%	92
7	M2-NS1	M65	0.1%	96
8	M2-NS2	M65	0.2%	99
9	M2-NS3	M65	0.3%	102
10	M2-NS4	M65	0.4%	106

B. Compressive Strength

TABLE IVV RESULTS OF COMPRESSIVE STRENGTH OF CONCRETE AT 7 DAYS OF CURING

Sr. No.	Name of sample	Grade of concrete	% Nano silica	Strength (N/mm^2)
1	M1-NS0	M60	0.0%	44.87
2	M1-NS1	M60	0.1%	45.46
3	M1NS2	M60	0.2%	47.77
4	M1-NS3	M60	0.3%	47.80
5	M1-NS4	M60	0.4%	47.99
6	M2-NS0	M65	0.0%	48.75
7	M2-NS1	M65	0.1%	48.98
8	M2-NS2	M65	0.2%	49.23
9	M2-NS3	M65	0.3%	49.78
10	M2-NS4	M65	0.4%	49.93

TABLE V RESULTS OF COMPRESSIVE STRENGTH OF CONCRETE AT 28 DAYS OF CURING

Sr. No.	Name of sample	Grade of concrete	% Nano silica	Strength (N/mm^2)
1	M1-NS0	M60	0.0%	69.87
2	M1-NS1	M60	0.1%	70.27
3	M1NS2	M60	0.2%	73.57
4	M1-NS3	M60	0.3%	73.86
5	M1-NS4	M60	0.4%	73.84
6	M2-NS0	M65	0.0%	74.66
7	M2-NS1	M65	0.1%	75.23
8	M2-NS2	M65	0.2%	76.48
9	M2-NS3	M65	0.3%	76.89
10	M2-NS4	M65	0.4%	76.77

C. Split Tensile Strength

TABLE VI Results of Split tensile strength of concrete at 7 days of curing

Sr. No.	Name of sample	Grade of concrete	% Nano silica	Strength (N/mm^2)
1	M1-NS0	M60	0.0%	4.54
2	M1-NS1	M60	0.1%	4.65
3	M1NS2	M60	0.2%	4.89
4	M1-NS3	M60	0.3%	4.91
5	M1-NS4	M60	0.4%	4.79
6	M2-NS0	M65	0.0%	4.89
7	M2-NS1	M65	0.1%	4.97
8	M2-NS2	M65	0.2%	5.23
9	M2-NS3	M65	0.3%	5.48
10	M2-NS4	M65	0.4%	5.46

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TABLE VII Results of Split tensile strength of concrete at 28 days of curing

Sr. No.	Name of sample	Grade of concrete	% Nano silica	Strength (N/mm^2)
1	M1-NS0	M60	0.0%	7.01
2	M1-NS1	M60	0.1%	7.27
3	M1NS2	M60	0.2%	7.35
4	M1-NS3	M60	0.3%	7.48
5	M1-NS4	M60	0.4%	7.46
6	M2-NS0	M65	0.0%	7.75
7	M2-NS1	M65	0.1%	7.88
8	M2-NS2	M65	0.2%	7.97
9	M2-NS3	M65	0.3%	8.01
10	M2-NS4	M65	0.4%	7.94

D. Flexural Strength

TABLE VIII Results of Flexural strength of concrete at 7 days of curing

Sr. No.	Name of sample	Grade of concrete	% Nano silica	Strength (N/mm^2)
1	M1-NS0	M60	0.0%	5.75
2	M1-NS1	M60	0.1%	5.90
3	M1NS2	M60	0.2%	6.33
4	M1-NS3	M60	0.3%	6.39
5	M1-NS4	M60	0.4%	6.28
6	M2-NS0	M65	0.0%	6.24
7	M2-NS1	M65	0.1%	6.66
8	M2-NS2	M65	0.2%	6.97
9	M2-NS3	M65	0.3%	7.03
10	M2-NS4	M65	0.4%	6.89

TABLE IX Results of Flexural strength of concrete at 28 days of curing

Sr. No.	Name of sample	Grade of concrete	% Nano silica	Strength (N/mm^2)
1	M1-NS0	M60	0.0%	8.99
2	M1-NS1	M60	0.1%	9.13
3	M1NS2	M60	0.2%	9.57
4	M1-NS3	M60	0.3%	9.62
5	M1-NS4	M60	0.4%	9.63
6	M2-NS0	M65	0.0%	9.17
7	M2-NS1	M65	0.1%	9.37
8	M2-NS2	M65	0.2%	9.51
9	M2-NS3	M65	0.3%	9.66
10	M2-NS4	M65	0.4%	9.59

E. Rapid Chloride Permeability Test

TABLE X Results of RCPT test

Sr. No.	Name of sample	Grade of concrete	% Nano silica	Charge passed In Coulombs (c)	Chloride permeability
1	M1-NS0	M60	0.0%	2130	Moderate
2	M1-NS1	M60	0.1%	1970	Low
3	M1NS2	M60	0.2%	1802	Low
4	M1-NS3	M60	0.3%	1740	Low
5	M1-NS4	M60	0.4%	1720	Low
6	M2-NS0	M65	0.0%	2086	Moderate
7	M2-NS1	M65	0.1%	1977	Low
8	M2-NS2	M65	0.2%	1805	Low
9	M2-NS3	M65	0.3%	1709	Low
10	M2-NS4	M65	0.4%	1708	Low

F. Water Sorptivity Test

TABLE XI Results of Water sorptivity test

Sr. No.	Name of sample	Grade of concrete	% Nano silica	Dry Wt in Grams (W1)	Wet Wt in grams (W2)	Sorptivity Value in 10^{-5} mm/min$^{0.5}$
1	M1-NS0	M60	0.0%	931	932.6	0.01073
2	M1-NS1	M60	0.1%	922.8	924.2	0.0100
3	M1NS2	M60	0.2%	929	930	0.00716
4	M1-NS3	M60	0.3%	933	933.7	0.00501
5	M1-NS4	M60	0.4%	927.4	928.1	0.00501
6	M2-NS0	M65	0.0%	919.9	921.3	0.01001
7	M2-NS1	M65	0.1%	930.1	931.2	0.00788
8	M2-NS2	M65	0.2%	929.4	930.2	0.00573
9	M2-NS3	M65	0.3%	931.5	932.1	0.00430
10	M2-NS4	M65	0.4%	926.7	927.2	0.00358

G. Acid Attack Test

TABLE XII Results of Acid attack test

Sr. No.	Name of sample	Grade of concrete	% Nano silica	Wt. of cube before immersing in H_2SO_4 (gm)	Wt. of cube after immersing in H_2SO_4 (gm)	Strength of cube before acid test (N/mm^2)	Strength of cube after acid test (N/mm^2)	% of Decrease of Strength
1	M1-NS0	M60	0.0%	8580.2	7958.13	69.87	64.64	7.48
2	M1-NS1	M60	0.1%	8588	7986.84	70.27	65.20	7.21
3	M1NS2	M60	0.2%	8580.7	8022.95	73.57	68.61	6.73
4	M1-NS3	M60	0.3%	8582.3	8058.77	73.86	69.14	6.39
5	M1-NS4	M60	0.4%	8577	8062.38	73.84	69.10	6.41
6	M2-NS0	M65	0.0%	8595.4	7984.26	74.66	69.14	7.39
7	M2-NS1	M65	0.1%	8597.1	8012.49	75.23	69.94	7.03
8	M2-NS2	M65	0.2%	8576.5	8019.88	76.48	71.34	6.72
9	M2-NS3	M65	0.3%	8588	8073.57	76.89	72.09	6.24
10	M2-NS4	M65	0.4%	8598.3	8083.26	76.77	71.97	6.25

H. Sulphate Attack Test

TABLE XIII Results of Sulphate attack test

Sr. No.	Name of sample	Grade of concrete	% Nano silica	Wt. of cube before immersing in MgSo4 (gm)	Wt. of cube after immersing in MgSo4 (gm)	Strength of cube before sulphate test (N/mm^2)	Strength of cube after sulphate test (N/mm^2)	% of Decrease of Strength
1	M1-NS0	M60	0.0%	8580.2	8312.49	69.87	67.27	3.71
2	M1-NS1	M60	0.1%	8588	8330.36	70.27	67.83	3.47
3	M1NS2	M60	0.2%	8580.7	8348.16	73.57	71.33	3.04
4	M1-NS3	M60	0.3%	8582.3	8375.38	73.86	71.74	2.87
5	M1-NS4	M60	0.4%	8577	8376.87	73.84	71.69	2.90
6	M2-NS0	M65	0.0%	8595.4	8329.70	74.66	71.94	3.64
7	M2-NS1	M65	0.1%	8597.1	8356.38	75.23	72.66	3.41
8	M2-NS2	M65	0.2%	8576.5	8362.08	76.48	74.17	3.01
9	M2-NS3	M65	0.3%	8588	8405.74	76.89	74.66	2.89
10	M2-NS4	M65	0.4%	8598.3	8418.12	76.77	74.53	2.91

I. Oxygen Permeability Test

TABLE XIV Results of OPI test

Sr. No.	Name of sample	Grade of concrete	% Nano silica	Oxygen permeability index	Concrete Acceptance Quality As per South Africa code
1	M1-NS0	M60	0.0%	9.71	Good
2	M1-NS1	M60	0.1%	9.75	Good
3	M1NS2	M60	0.2%	9.79	Good
4	M1-NS3	M60	0.3%	9.80	Good
5	M1-NS4	M60	0.4%	9.80	Good
6	M2-NS0	M65	0.0%	9.76	Good
7	M2-NS1	M65	0.1%	9.78	Good
8	M2-NS2	M65	0.2%	9.83	Good
9	M2-NS3	M65	0.3%	9.85	Good
10	M2-NS4	M65	0.4%	9.86	Good

VIII. CONCLUSIONS

1) The workability of concrete is increase as the percentages of nano silica increase in both grade but M60 grade of concrete with nano silica have better results of slump (workability test).

2) As per the results of strength test of concrete with nano silica improve the properties of concrete like compressive strength, split tensile strength and flexural strength test. The results of strength test are showing that adding more nano silica in concrete that it give higher strength especially at 0.3% of nano silica give higher strength as compare to control mix but at the 0.4% of nano silica the results of all strength test was decrease.

3) So, based on the strength test the optimum percentage of nano silica that can be added in concrete was 0.3% because at the 0.4% of nano silica the strength slightly decreases.

4) Water sorptivity results for all mixes falls in good category having values between 0 to 4.Water sorptivity value decrease as percentage of nano silica are increase in concrete. M65 grade of concrete perform better in Water Sorptivity test as compare to M60 grade of concrete. Here in this test concrete with nano silica is give better results as compare to the control mix.

5) Rapid Chloride permeability test Results the chloride ion permeability of all mixes falls in good category (moderate and low). As far as the nano silica is used in the sample of concrete, the results are in good category that means they have low chloride permeability. There is no major difference between the results of 0.3% of nano silica and 0.4% of nano silica for RCPT.

6) In the Acid attack and Sulphate attack the results of concrete with nano silica was better as compare to control mix. Here in the acid attack test the strength is reduce up to 6.24% with use of nano silica and in the sulphate attack test the strength is reduce up to 2.87% with use of nano silica.

7) From the OPI result, it was found that, there is a minor variation between the various two types mix and OPI for all mixes was found to be a good quality having value between 9.5 to 10.0; Nano silica also gives good results in this test.

8) Incorporation of nano silica with OPC reduced the oxygen permeability and chloride ion permeability; means nano silica mixes have better durability than OPC mix.

9) Based on the results of workability, strength and durability it is determine that the use of nano silica is giving better performance in the all test as compare to control mix.

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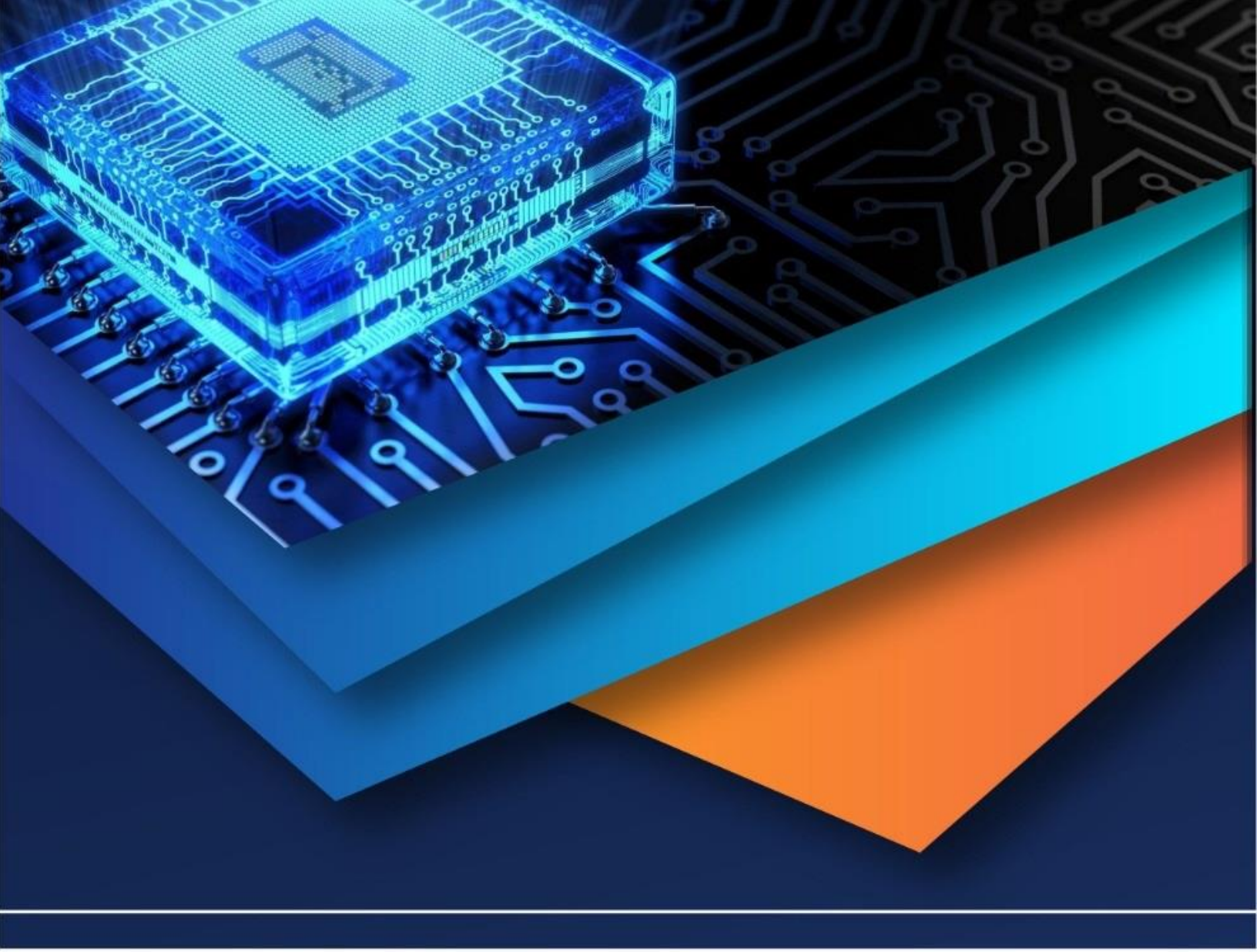
REFERENCES

[1] IS 456: 2000, “Indian Standard Code of Practice for Plain and Reinforced Concrete”, Bureau of Indian Standard, New Delhi
[2] IS 10262: 1982, “Recommended Guidelines for Concrete Mix design”, Bureau of Indian Standard, New Delhi
[3] IS 383: 1970, “Specification for Coarse aggregate and Fine aggregate from Natural Sources for Concrete”, Bureau of Indian Standard, New Delhi
[4] IS 9103: 1999, “Indian Standard Concrete Admixture Specification”, Bureau of Indian Standard, New Delhi
[5] IS 5816: 1999, “Splitting Tensile Strength of Concrete Method of Test”, Bureau of Indian Standard, New Delhi
[6] IS 9399: 1959, “Specification for Apparatus for Flexural Testing of Concrete”, Bureau of Indian Standard, New Delhi
[7] IS 516: 1959, “Flexural Strength of Concrete”, Bureau of Indian Standard, New Delhi
[8] IS: 2386-1963 (Part-III). Methods of Test for aggregates for concrete Part III specific gravity, density, voids, absorption and bulking. Bureau of Indian Standards.
[9] M.S. Morsy, S.H. Alsayed and M. Aqel. (2010). Effect of Nano clay on mechanical properties and microstructure of Ordinary Portland Cement mortar. International Journal on Civil Engineering & Environmental Engineeering IJCEE-IJENS Vol. 10 No. 01.
[10] Nilli, M., Ehsani, A. and Shabani, K. (2009). Influence of nano SiO2 and micro silics on concrete performance. Bu-Ali Sina University Iran.
[11] Ali Nazari, Shadi Riahi, Shirin Riahi, Saydeh Fatemeh Shamekhi and A. Khademno. (2010). Mechanical properties of cement mortar with Al2O3 nanoparticles. Journal of American Science 6(4), 94-97.
[12] Givi, A. N. and Rashid, S. A. (2011). The effect of lime solution on the properties of SiO2 nanoparticles binary blended concrete. Composites (Part B) Vol. 42, 562-569.
[13] eidari, A., and Tavakoli, D. (Sept 2012). A study of mechanical properties on ground ceramic powder concrete incorporating nano SiO2 particles. Construction and Building Materials Vol. 38, 255-264.
[14] Shakir A. Al-Mishhamid, Amer M.Ibraham and Zeinab H. Naji (2013). The effect of nano metakaolin materials on some properties of concrete. Diyala Journal of Enginnering Sciences, Vol. 06, No. 01, 50-61.
[15] Rathi, V.R. and Modhera, Dr. C.D. (2014). An overview on the influence of Nano materials on properties of concrete. International Journal of Innovative Research in science, Engineering and Technology, Vol. 3, Issue 2



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