



Durability Study on Nano Concrete

**P.Vasanthi^{1*}, S.Senthilselvan², D.Benita Hexton³,
Mohamed Salman Farooq.I⁴, and P.Suresh⁵**

^{1,3,4,5}Department of Civil Engineering, Sathyabama University, Chennai, India.

²Department of Civil Engineering, SRM University, Chennai, India.

Abstract : The use of nano materials in concrete is gaining increasing attention in the construction industry. Studies have shown that concrete containing nano particles has demonstrated increased strength, durability and reduction of pores in the concrete due to the pore filling properties of the nano materials. This also results in increased resistance to corrosion of the steel reinforcements. Hence, the nano materials are useful to improve the life of the building. The use of large quantity of cement produces increasing CO₂ emissions and also consequents the greenhouse effect. The nano materials are used in order to reduce the cement content in the concrete mix. Nano material represents one of the most outstanding advances in concrete technology during the last decade. Due to its specific properties, nano materials may constitute the significant improvement of the quality of the concrete structure and open up new fields for the application of concrete. Nano material is spread all over the world with a steady increase in number of applications. Nano materials are intentionally produced and designed with very specific properties related to shape, size and surface properties. The main use of nano materials in concrete is to increase the strength. Nano Silica produces high compressive strength concrete. It also provides high workability with reduced water cement ratio.

Keywords : Portland Pozzolana Cement, Nano Silica, Polycarboxylate, Hydrochloric Acid, Sodium Hydroxide, Sodium Sulphate.

Introduction

The advancement made in the study of concrete at nano scale has shown that addition of Nano-silica leads to the densifying of the micro and nanostructure resulting in improved mechanical properties. Significant improvement was observed in mixtures incorporating nano-silica in terms of reactivity, strength development, refinement of pore structure and densification of interfacial transition zone. This also results in a lower rate of corrosion of the steel reinforcements due to the pore filling nature of the nano silica particles in the concrete. If Portland cement can be manufactured using the nano sized particles, it will open up a large number of opportunities for further research and development of concrete used in construction industry. The nano particles also make the cement more environmentally friendly and reduce the impact of the construction industry on the environment, hence leading to a more sustainable future. The cement manufactured using this method will not only be more economical than ordinary cement polymers, but will also have a fire resistance. Hence the structure built using nano particles will be stronger and more durable than conventional concrete, which in turn increases the service life of the building.

Experimental Work

In this work, Study the properties and durability of Nano concrete and to determine the compression strength of cubes with 2% of nano silica on M40 grade that has been immersed in HCL (acid test), NaOH (alkaline test) and Na_2SO_4 (sulphate test). Materials used for this project Portland Pozzolana Cement (53 grade) conforming to IS 1489:1991 has been used. River sand passing through 2.36mm sieve is used as the fine aggregate and gravel of 12mm and below size is used as the coarse aggregate. Nano silica is the first product that replaced the micro silica. Nano Silica produces high compressive strength concrete. Polycarboxylates are chemical admixtures that can be added to concrete mixture to improve workability.

Curing Method

- The chemical solution for curing is prepared by mixing the required chemicals with water.
- The concrete cubes are immersed inside the chemical solution containing 0.5ml of HCL acid with 6 litres of water for the acid test.
- The concrete cubes are immersed inside the chemical solution containing 426gms of Na_2SO_4 in 6 litres of water for the sulphate test.
- The concrete cubes are immersed inside the chemical solution containing 24gms of NaOH in 6 litres of water for the alkaline test.
- The cubes are left immersed in the chemical solution and the pH of the solution is checked periodically using a pH meter.
- The cubes are left immersed in the chemical solution until the day of testing as shown in Fig 1.
- The cubes are then tested on compression testing machine to measure their strength and durability.



Fig 1: Curing Method

Results

Testing of the Specimens

Compression Test on Acid Test (using Hydrochloric Acid)

- The 14 days compression strength of the concrete cubes without nano silica shows the value of 28.7, concrete with 2% of nano silica shows the value of 33.05. The comparison of the 14 days strength results shows that concrete with 2% of nano silica shows an increase of 15% with respect to the nominal concrete.

- The 21 days compression strength of the concrete cubes without nano silica shows the value of 37.33, concrete with 2% of nano silica shows the value of 42.92. The comparison of the 21 days strength results shows that concrete with 2% of nano silica shows an increase of 15% with respect to the nominal concrete.
- The 28 days compression strength of the concrete cubes without nano silica shows the value of 41.8, concrete with 2% of nano silica shows the value of 48.07. The comparison of the 28 days strength results shows that concrete with 2% of nano silica shows an increase of 15% with respect to the nominal concrete.
- The results of the compression test are shown in the below table 1.

Table 1: Compression test results in M40 grade of concrete for the ACID TEST:

Percentage of Nano silica used	Compressive strength of cubes at 14 th day (N/mm ²)	Compressive strength of cubes at 21 th day (N/mm ²)	Compressive strength of cubes at 28 th day (N/mm ²)
0	28.7	37.33	41.8
2	33.05	42.92	48.07

Compression Test on Alkaline Test (using Sodium Hydroxide)

- The 14 days compression strength of the concrete cubes without nano silica shows the value of 28.92, concrete with 2% of nano silica shows the value of 37.70. The comparison of the 14 days strength results shows that concrete with 2% of nano silica shows an increase of 20% with respect to the nominal concrete.
- The 21 days compression strength of the concrete cubes without nano silica shows the value of 38.41, concrete with 2% of nano silica shows the value of 46.09. The comparison of the 21 days strength results shows that concrete with 2% of nano silica shows an increase of 20% with respect to the nominal concrete.
- The 28 days compression strength of the concrete cubes without nano silica shows the value of 42.80, concrete with 2% of nano silica shows the value of 51.36. The comparison of the 28 days strength results shows that concrete with 2% of nano silica shows an increase of 20% with respect to the nominal concrete.
- The results for the alkaline test are shown below in the table 2 and Fig 2.

Table 2: Compression test in M40 grade of concrete for the ALKALINE TEST:

Percentage of Nano Silica Used	Compressive Strength of Cubes at 14 th Day (N/mm ²)	Compressive Strength of Cubes at 21 st Day (N/mm ²)	Compressive Strength of Cubes at 28 th Day (N/mm ²)
0	28.92	38.41	42.80
2	37.70	46.09	51.36

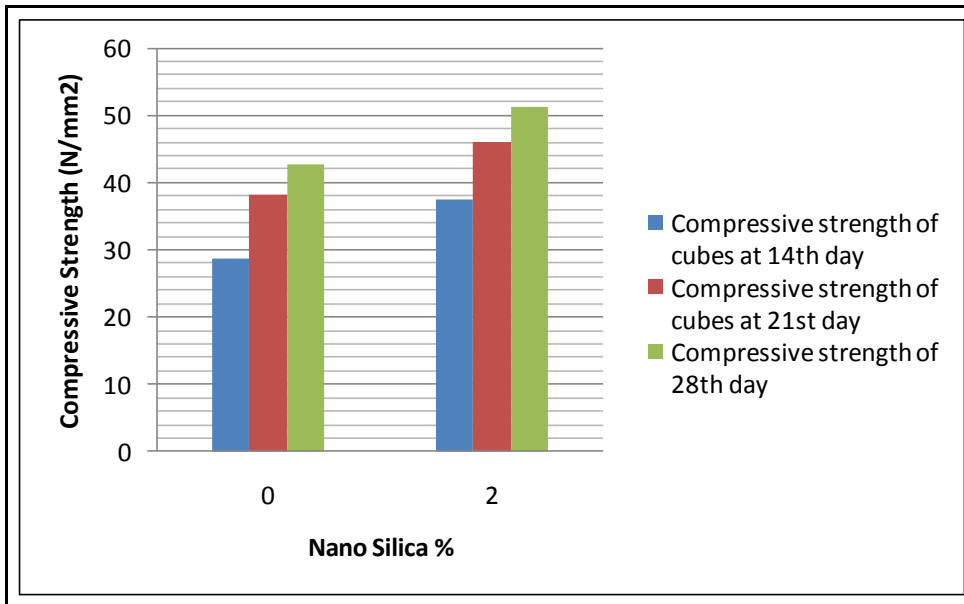


Fig 2: Compression Test on Alkaline Test

Compression Test on Sulphate Test (using Sodium Sulphate)

- The 14 days compression strength of the concrete cubes without nano silica shows the value of 28.9, concrete with 2% of nano silica shows the value of 34.68. The comparison of the 14 days strength results shows that concrete with 2% of nano silica shows an increase of 20% with respect to the nominal concrete.
- The 21 days compression strength of the concrete cubes without nano silica shows the value of 37.40, concrete with 2% of nano silica shows the value of 44.88. The comparison of the 21 days strength results shows that concrete with 2% of nano silica shows an increase of 20% with respect to the nominal concrete.
- The 28 days compression strength of the concrete cubes without nano silica shows the value of 41.86, concrete with 2% of nano silica shows the value of 50.23. The comparison of the 28 days strength results shows that concrete with 2% of nano silica shows an increase of 20% with respect to the nominal concrete.
- The results for the sulphate test are shown below in the table 3 and fig 3.

Table 3: Compression test in M40 grade of concrete for the SULPHATE TEST:

Percentage of Nano Silica Used	Compressive Strength of Cubes at 14 th Day (N/mm ²)	Compressive Strength of Cubes at 21 st Day (N/mm ²)	Compressive Strength of Cubes at 28 th Day (N/mm ²)
0	28.9	37.40	41.86
2	34.68	44.88	50.23

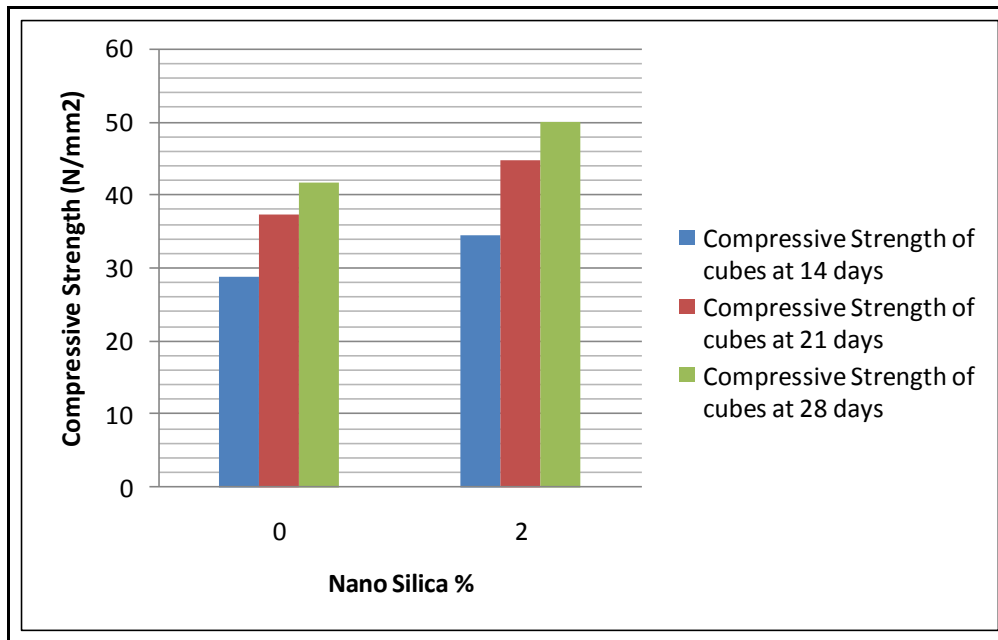


Fig 3: Compression Test on Sulphate Test

Conclusion

- The purpose of this experiment was to determine the effects of addition of nano silica to the concrete mix.
- The durability of the concrete containing 2% of Nano silica has been studied by using the acid, alkali and sulphate attack.
- The test results have shown that the M40 grade of concrete mixed with 2% of Nano silica shows a 15% increase in strength when compared to the standard M40 grade concrete immersed in concentrated HCL solution.
- Also, the test samples have shown an increase in strength up to 20% for those samples which were immersed in Na_2SO_4 solution and NaOH solution.
- Hence it has been proven that addition of Nano silica to the concrete mix results in an increase in the compressive strength and durability when compared to the ordinary concrete mix.

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