

Mechanical Properties of Nano Silica Concrete

P.Janani¹, S.Ganeshkumar², M.Harihananth³

P.G. Scholar, Department of Civil Engineering, Erode Builder Educational Trust's Group of Institutions, Kangayam, India¹

P.G. Scholar, Department of Civil Engineering, Bannari Amman Institute of Technology, Sathyamangalam, India²

Assistant Professor, Department of Civil Engineering, Erode Builder Educational Trust's Group of Institutions, Kangayam, India³

ABSTRACT: This experimental work was carried out to investigate the strength of the mechanical properties of Nano silica concrete and compared with the normal cement concrete. In this study, the Nano silica is used as a supplementary cementitious replacement material for cement. The silica has been subjected to ball milling technique and the size of Nano silica has been confirmed to its characterization by Scanning Electron Microscope (SEM) analysis. The Compression test is conducted for various percentage replacements of silica to find the optimum percentage of silica replacement. From the test, 23% replacement of cement to silica achieves the maximum strength. Hence, the mechanical properties such as Compression, Tensile and Flexural strength test were experimentally studied with 23% of cement replaced with Nano silica and the results were compared with that of Normal Cement Concrete (NCC).

I. INTRODUCTION

Concrete is the most widely used construction material in the world. In recent years, researchers have focused on the improvement of concrete quality regarding its mechanical and durability properties. These can be achieved by the application of the supplementary cementitious materials. The silica fume is the one of the waste materials that is being produced in tones of industrial waste per year in our country. The study of concrete at nano scale has proved that nano silica is much better than conventional concrete. Nano silica possess more pozzolanic nature, it has the capability to react with the free lime during the cement hydration and forms additional C-S-H gel which gives strength, impermeability and durability to concrete.

II. EXPERIMENTAL WORK

Ball mill

The ball milling technique is adopted where to convert the silica to nano size. The ball mill is the equipment for grinding the particles and to reduce the size of the particles. Here, the ball mill is used to reduce the size of silica, from its original size to the small nano sized particles. Silica powder is taken, and filled the ball mill according to its capacity. Steel balls are put inside the equipment and allowed to rotate for certain hours. The particle loses its texture and the powder particles get reduced in size by increasing the surface area.

SEM analysis was done for particle size confirmation for its nano size.

Mix Proportioning

Experimental investigations have been carried out on the Nano silica concrete test specimens to ascertain the mechanical properties such as compressive strength, split tensile strength, and flexural strength and compared with the strength of the conventional and raw silica concrete. Here 23% replacement with cement were made and M20 mix proportions were taken. The water cement ratio of about 0.45 is taken with experimental test on Marsh cone.

Preparation of test specimens

Totally 45 specimens were casted to determine the mechanical properties of the concrete. The size of specimen includes cube of size 150 mm × 150 mm × 150 mm, cylinder of size 150mm dia and 300 mm height and prism of size

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

100 mm × 100 mm × 500 mm is used.

II. ANALYSIS OF TEST RESULTS

SEM Analysis:

SEM analysis is done to confirm the size of silica. For SEM analysis the cube is casted, cured and after attaining the 28 days strength the specimen is cut into 1cm x 1cm x 1cm size. Then this sample is given for SEM analysis report and the result is achieved as image as shown in Figure 1.

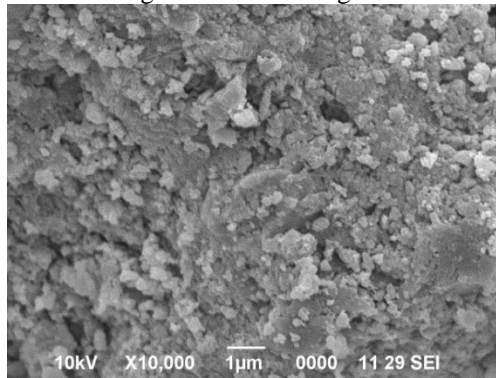


Figure 1: SEM image for Nano silica

Marsh Cone Test:

To find the optimum w/c ratio, the time taken for 500ml paste flow for different w/c was measured for 5min and 60min is noted and shown in table 1

Table 1: Marsh cone test

S. No.	w/c ratio	log (flow time, sec)	
		at 5 mins	at 60 mins
1	0.3	15.10	66.73
2	0.35	12.5	63.56
3	0.4	11.7	57
4	0.45	9.62	55.89
5	0.5	9.8	54.2
6	0.55	9.6	53.5
7	0.6	9.5	53

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

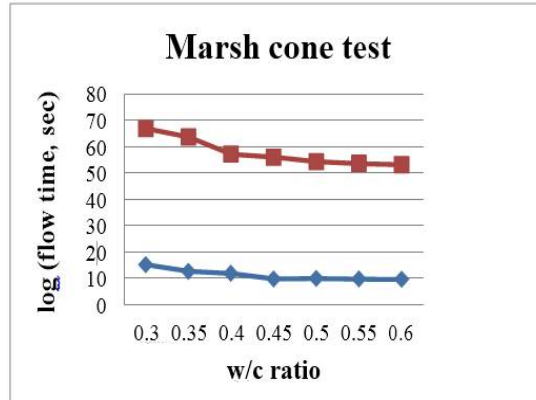


Figure 2: Marsh Cone test

Optimum Percentage:

The variation of compressive strength with various percentage of nano silica replacement by weight of cement is made to find the optimum w/c content. The results of compressive strength of cubes are obtained and are shown in table 2.

Table 2: Compressive strength of Nano silica concrete

Percentage replacement of Cement with Nano Silica	Compressive Strength (N/mm ²)
10%	21.2
15%	23.6
20%	26.4
25%	25.7
30%	24

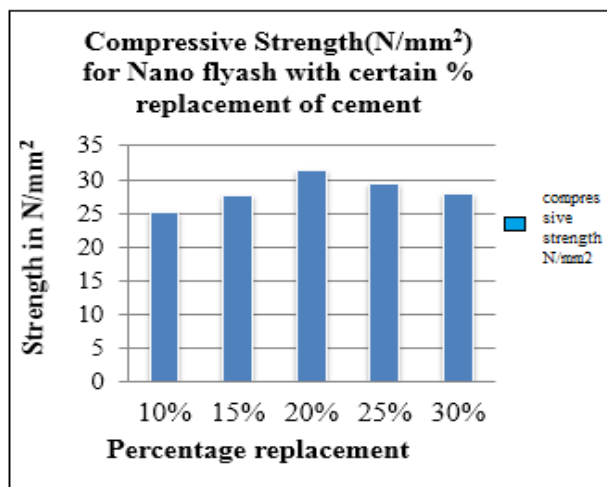


Figure 3: Comparison of Compressive strength of Nano silica

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

This figure shows that there is increase in Compressive strength of Nano silica concrete in 20% and decrease in 25% of replacement. Therefore, adopting 23% replacement of cement to silica for further test.

After curing, the specimens were tested for 28 days strength of Compression, Split tensile and Flexural test for 3 different mixes such as conventional and 23% replacement of cement to raw silica and nano silica concrete are compared and their results are tabulated.

Compression test: The compressive strength test value for three mixes are shown in the following tables, results were compared and shown in Figure. It shows the compressive strength for nano silica concrete increases its strength compared to conventional and raw silica concrete.

Table 3: Conventional concrete mix

Specimen	Compressive strength (N/mm ²)	Average compressive strength (N/mm ²)
1	20.4	20.9
2	21	
3	21.3	

Table 4: 23% replacement of cement to raw silica concrete mix

Specimen	Compressive strength (N/mm ²)	Average compressive strength (N/mm ²)
1	25	24.33
2	24.6	
3	23.5	

Table 5: 23% replacement of cement to nano silica concrete mix

Specimen	Compressive strength (N/mm ²)	Average compressive strength (N/mm ²)
1	27.3	27.73
2	28	
3	27.9	

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

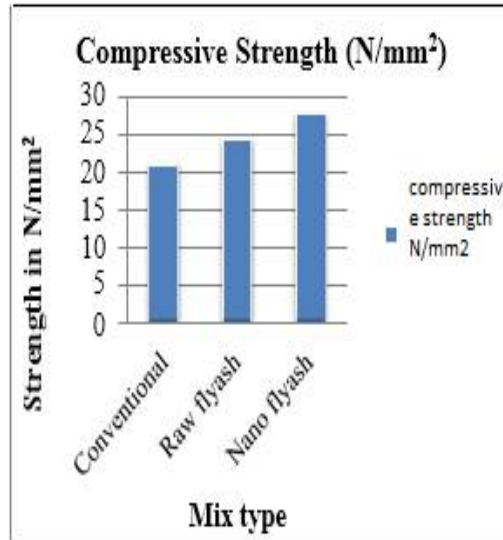


Figure 4: Comparison of Compressive strength

Split tensile strength test: The tensile strength test value for three mixes are shown in the following tables, results were compared and shown in Figure. It shows the tensile strength for nano silica concrete increases its strength compared to conventional and raw silica concrete.

Table 6: Conventional concrete mix

Specimen	Split tensile strength (N/mm ²)	Average split tensile strength (N/mm ²)
1	2.7	2.4
2	2	
3	2.5	

Table 7: 23% replacement of cement to raw silica concrete mix

Specimen	Split tensile strength (N/mm ²)	Average split tensile strength (N/mm ²)
1	3	2.9
2	2.5	
3	3.2	

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

Table 8: 23% replacement of cement to nano silica concrete mix

Specimen	Split tensile strength (N/mm ²)	Average split tensile strength (N/mm ²)
1	3.9	3.93
2	3.7	
3	4.2	

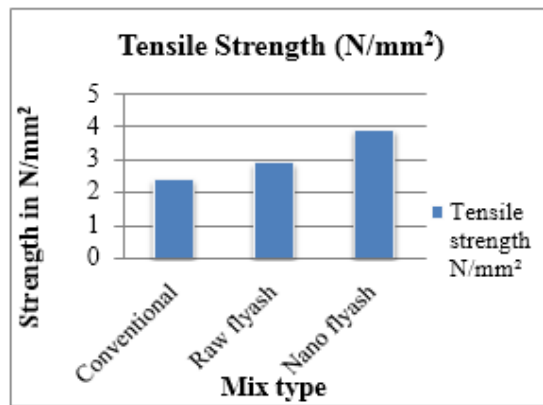


Figure 4: Comparison of Tensile strength

Flexural strength test: The flexural strength test value for three mixes are shown in the following tables, results were compared and shown in Figure. It shows the flexural strength for nano silica concrete increases its strength compared to conventional and raw silica concrete.

Table 9: Conventional concrete mix

Specimen	Modulus of Rupture (N/mm ²)	Average strength (N/mm ²)
1	4	4
2	4.2	
3	3.8	

Table 10: 23% replacement of cement to raw silica concrete mix

Specimen	Modulus of Rupture (N/mm ²)	Average strength (N/mm ²)
1	3.6	3.8
2	4	
3	3.8	

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

Table 11: 23% replacement of cement to nano silica concrete mix

Specimen	Modulus of Rupture (N/mm ²)	Average strength (N/mm ²)
1	4.7	4.9
2	5.2	
3	5	

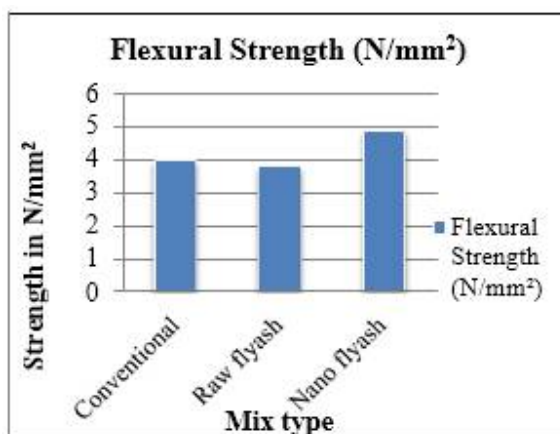


Figure 4: Comparison of Flexural strength

IV.CONCLUSIONS

In this project three different concrete mixes have been compared to find the Strength properties of nano silica concrete. In this, the compressive strength of using 23% replacement of nano silica to cement increases 32.69% compared to conventional mix, the tensile strength of using 23% replacement of nano silica to cement increases 24.6% compared to conventional mix, and the flexural strength of using 23% replacement of nano silica to cement increases 22% compared to conventional mix. And the further more durability properties will be experimentally determined later and their results should be discussed and compared in future study.

REFERENCES

1. Kare Hjorteset, Markus Wernli, Michael W. LaNier, Kimberly A. Hoyle and William H. Oliver (2016), "An Experimental Study On High Performance Concrete By Optimum Replacement Level Of Cement With Nano Silica & Silica Fumes", International Journal of Emerging Technology in Computer Science & Electronics Volume 19.
2. C. K. Sridhar, S. B. Vanakudre (2014), "Strength Efficiency Factor for Nano Silica at Different Age ", International Journal of Engineering and Advanced Technology, Volume-3.
3. S. Tanveer Hussain, K.V.S.Gopala Krishna Sastry (2014), "Study Of Strength Properties Of Concrete By Using Micro Silica And Nano Silica", International Journal of Research in Engineering and Technology (Volume 3).
4. M.Iyappan, A.Jaganathan (2014), "High Strength Self Compacting Concrete with Nano Silica", International Journal of Emerging Trends in Engineering and Development Vol.5.
5. Mostafa.Khanzad, Mohsen.Tadayon Hamed. Sepehri and Mohammad. Sepehri (2014), Influence of Nano Silica Particles on Mechanical Properties and Permeability of Concrete", International Conference on Sustainable Construction Material and technologies.
6. Maheswaran S, Bhuvaneshwari B, Palani G.S, Nagesh R Iyer and Kalaiselvam S (2013), "An Overview on the Influence of Nano Silica in Concrete and a Research Initiative", Research Journal of Recent Sciences.
7. Saloma (2013), "Experimental Investigation on Nanomaterial Concrete " International Journal of Civil & Environmental Engineering
8. IS 10262-2009, "Recommended guidelines for concrete mix design", Bureau of Indian standards, New Delhi.
9. IS 456-2000, "Plain and reinforced concrete code of practise", Bureau of Indian standards, New Delhi.