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An Experimental Investigation Of The Behaviour Of OPC by Using GGBS and Nano Silica as Blended Material

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Abstract:

The most typical building material is concrete. Only the cement content determines the total production. Due to the fact that using a lot of cement increases CO2 emissions, nanosilica (nSiO2) is used as a cement substitute in concrete mixes to lower the cement content. The fundamental science of cementitious materials at the atomic or nanoscale is currently the main area of focus. Concrete has mechanical qualities and a large increase in cementitious material, and research is ongoing to improve its sustainability and durability. The impact of adding nano silica on the mechanical characteristics of concrete is summarised in this work. It includes information on the most recent advancements in the use of nano-silica in concrete and motors utilising regular Portland cement and blended cement.The nano silica is available in 10-50 nm as particle size. The 17nm particle size is used for the whole project. This paper aim is to study the mechanical properties of the specimen using the nano silica by replacement of the cement. The ratio in weight of the nano cement with respect to normal cement. The mortar specimen size is 70.6x70.6x70.6 mm. The concrete cube size is 150 x 150 x 150 mm was maintained and water cement ratio 0.40 was maintained throughout the project. The 0%, 1.5%, 3.5%, 5.5% and 7.5% of nano silica should be replaced with weight of the cement.

Keywords: *Nano silica, Compressive strength, Split tensile strength,X-Ray Diffraction, SEM analysis, Cement type: OPC and Blended Cement.*

INTRODUCTION:

Concrete's versatility durability and economy have made it the world's most used construction material. The India utilizes about 7.3 million cubic meter of concrete each year. Due to this the cost of construction increases and causes environment pollution. As the demand for concrete as a construction material increase, so also the demand for fine aggregate increase.

In recent years, Global warming and environmental destruction have become major problems. Heightening concern about worldwide ecological issues, changeover the large scale manufacturing, mass-utilization, mass-waste, society of the past to a zero-emission society is presently seen as essential.For reducing the pollution we used the nano-silica as the percentage replacement of the cement.

One of the most used nano-sized material is nano-silica. Nano-silica addition increases the compressive strength and it reduces the permeability of hardened concrete. The interesting properties of and the incorporation of nano–silica deteriorate consistency of cement composites.

The presence of nano silica contributed to the improvement of the compressive strength and split tensile strength.The performance of cement based material is strongly dependent on nano sized particles. The particles of calcium-silicate-hydrates (C-S-H) at the interfacial transition zone between the cement and aggregate.The nanosilica decreases the setting time when comparing with the silica fume.

In view of this advance the main aim of this experiment is to study the mechanical properties of the structure. In this study the influence of size 17 nm and quantity 0, 1.5, 3.5, 5.5 and 7.5% by weight of cement of nSiO2on the mechanical properties have been examined.

Fe_2O_3	≤0.003	0.001
Specific gravity	2.2-2.4(generalised)	
Particle size	17 nano meters	

Fig1: Collection of nano silica

4.2Tests for cement

4.2.1 Bulk Density

Bulk density is defined as the "weight of the aggregates mass and it divided by the volume of container". It is generally calculated in kg/m^3.Bulk density depends on the how densely the aggregate is packed and it also depend on size and shape of the particles. Bulk density of aggregates deals the light weight aggregates and also the heavy weight aggregates. For a given specific gravity, the angular aggregate will show lower bulk density with minimum voids is considered. Usually increase in bulk density should be 15 % for coarse aggregate and 15 % for fine aggregate.

Bulk density of an aggregate can be determined either in loose state or compacted state. Bulk density of dry sand is 1600 kg/m^3 and wet sand is 2100 kg/m^3. For aggregate the density value is 1600 to 1880 kg/m^3.

4.2.2 Specific gravity

Specific gravity is defined as the ratio of the mass of the substances to the mass of reference substances for the same given sample. The specific gravity of an aggregate may be either (a) absolute specific gravity or (b) apparent specific gravity. The absolute specific gravity of aggregate refers to the volume of solid materials excluding voids present in it. It is defined as the ratio of weight of solids to the weight an equal void-free volume of water at the standard temperature. The specific gravity is used in the calculation of yield of concrete or quantity of aggregate required for the volume of concrete.

4.2.3 Standard Consistency test:

For determining the initial, final setting time and soundness the standard consistency test has to be used.For determining the initial and final setting time the IS: 4031 (part-4)-1988 code should be used.

The consistency test is done by using Vicat apparatus. The vicat plunger having the 10mm diameter and 50 mm length. The plunger should penetrate to a depth of 5-7mm from the bottom of the Vicatmould and the needle should be 10±0.5mm diameter. To determine the quantity of water required to produce cement paste of standard consistency. At the 34 % of water the penetration should get 7 mm. For determining the setting time, the percentage of water required to produce a cement paste of normal consistency is used. Consistency depends upon the composition of cement. The test is required to be conducted in a temperature ($27^{0} \pm 2^{0}$ C).

4.2.3.1Initial and final setting time:

For determining the initial and final setting time the IS: 4031 (part-5)-1988 code should be used.

Generally initial and final setting time is determined by using the vicat apparatus. Initial setting time duration is required to delay the process of hydration or hardening and the final setting time is the time when the paste completely looses the plasticity.

For determining initial setting time 1mm diameter of the needle is used on the lower end of the apparatus. and the needle penetrates the test block to a depth equal to 33-35mm from the top of the mould is taken as initial setting time. The initial setting time is found out by taking the interval between the additions of water to cement. The initial time should be 30 minutes.

For final setting time replacing the plunger to the apparatus and the cement shall be considered as finally set and it does not sinks visibly and leave no impression.

Fig 2:Vicat apparatus

4.2.3.2 Fineness modulus of aggregate:

Fineness modulus of aggregates is an obtained by adding the total percentage of the sample of an retained aggregate on each standard sieves. The fineness modulus is an obtained by adding the cumulative percentage of aggregates. The standard sieves ranging from 80 mm to 150 micron and dividing this sum by 100. The sieve analysis is used to determine the particle size distribution. If the aggregate gives a higher fineness modulus, the mix will be harsh and if the test aggregate gives a lower fineness modulus is also important for measuring the slight variations in the properties of aggregate.

Tests for fine aggregate:

Table 2: Sand grain size

Si.NO	I.S.Sieve size	Weight of the sample (kg)	Cumulative sample weight (kg)	Cumulative % of Weight retained (Kg)	Cumulative % of Weight passing (Kg)
1	4.75 mm	0	0	0	100
2	2.36 mm	0.03	0.03	3	97
3	1.18 mm	0.26	0.29	29	71
4	600 microns	0.07	0.36	36	64
5	300microns	0.15	0.51	51	49
6	150 microns	0.12	0.63	63	37
7	Pan	0.37	1.000	100	0
	Total	1.000		282	

Fineness Modulus = 282.00/100 = 2.82.

5. RESULTS AND DISCUSSIONS:

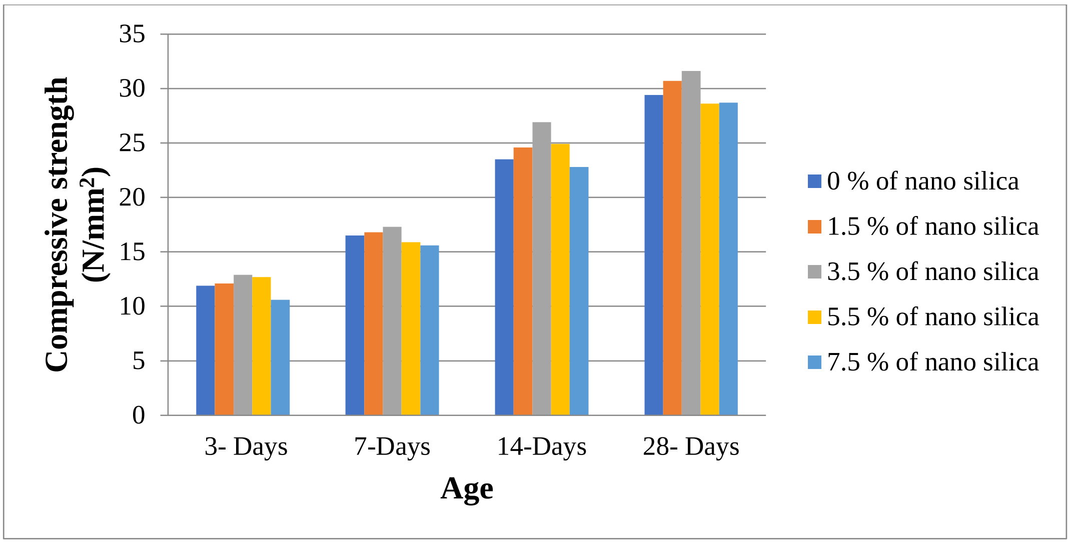
This chapter deals the strength properties and results of the compressive strength for mortar cubes and concrete cubes, split tensile strength by without replacement of cement and with replacement of cement by nano Silica.

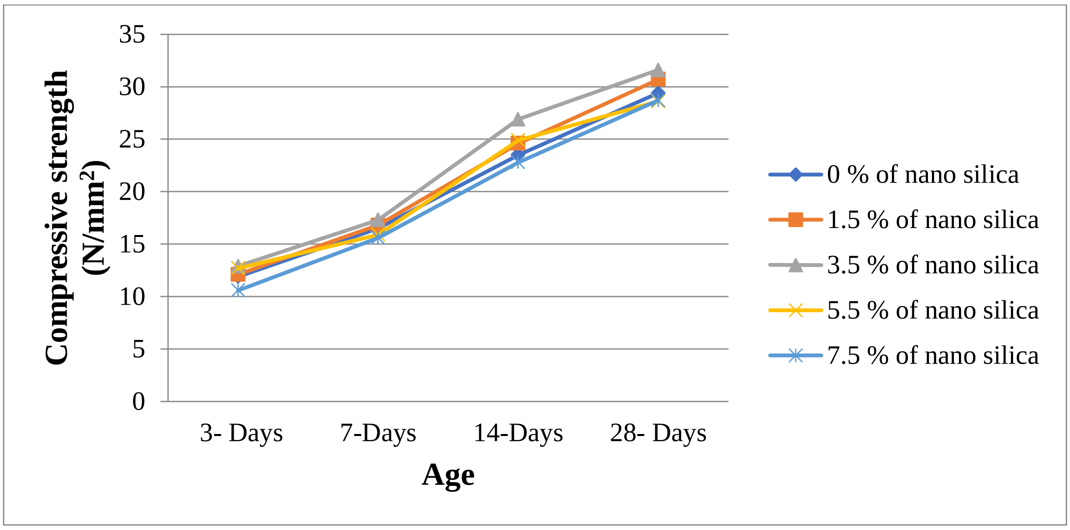
The result of the present experimental investigation is shown in tabular and graphical method.

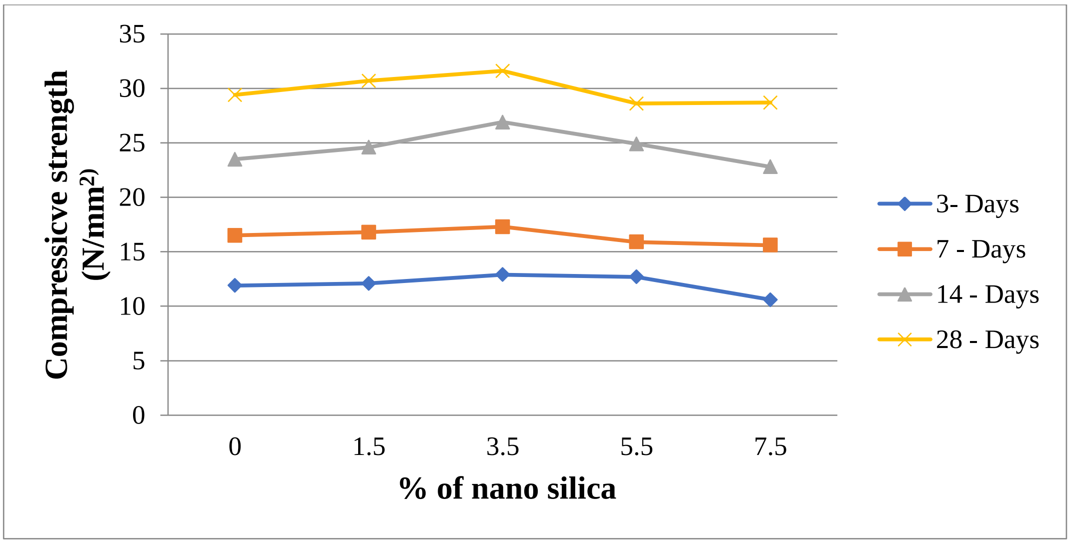
5.1 Using OPC

Table: Results for cement mortar by using OPC

Sl. No	% replacement of nano silica	Description	3 days	7 days	14 days	28 days
1	0	P.C	11.9	16.5	23.5	29.4
2	1.5	$nSiO_2$	12.1	16.8	24.6	30.7
3	3.5	$nSiO_2$	12.9	17.3	26.9	31.6
4	5.5	$nSiO_2$	12.7	15.9	24.9	28.6
5	7.5	$nSiO_2$	10.6	15.6	22.8	28.7





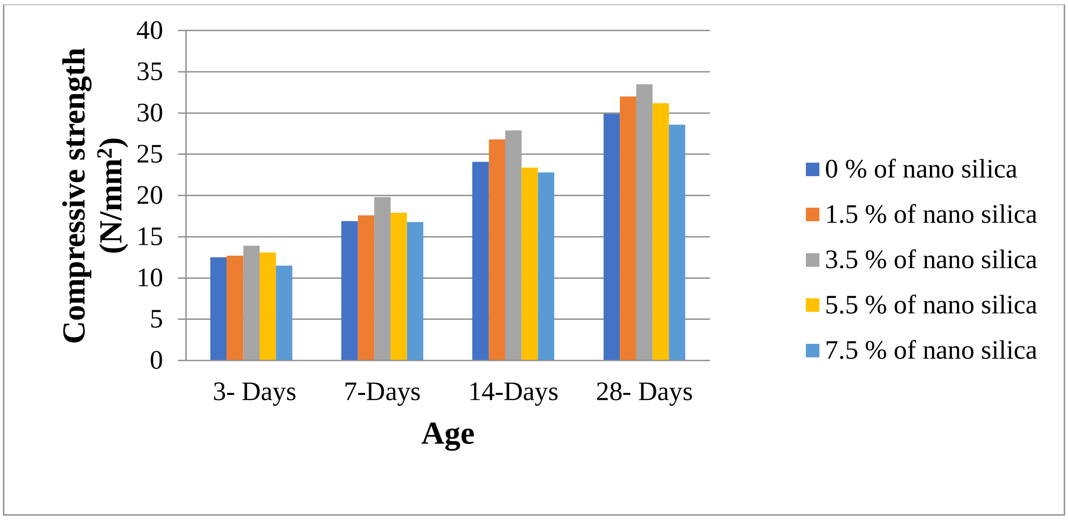


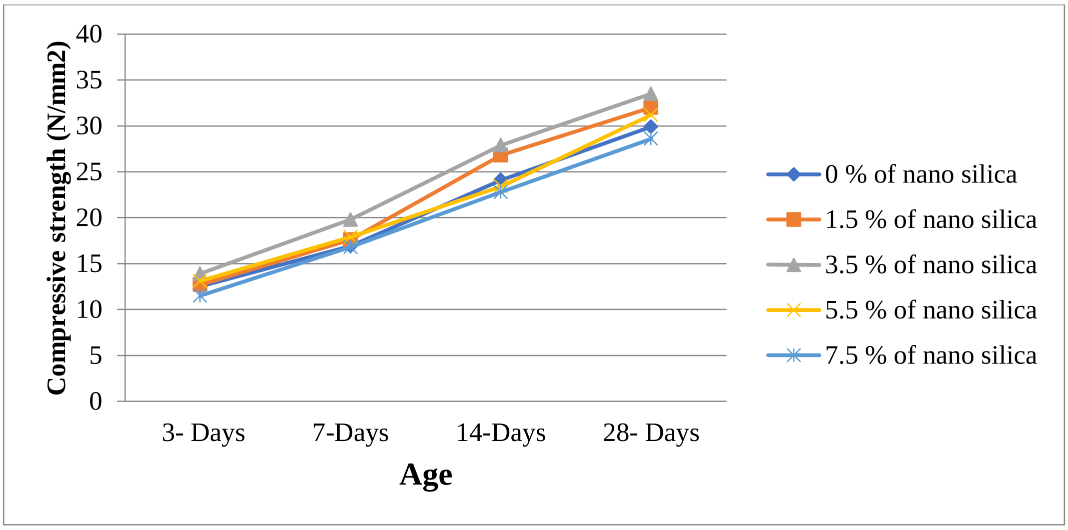
Graph3 :Cement mortar by using OPC

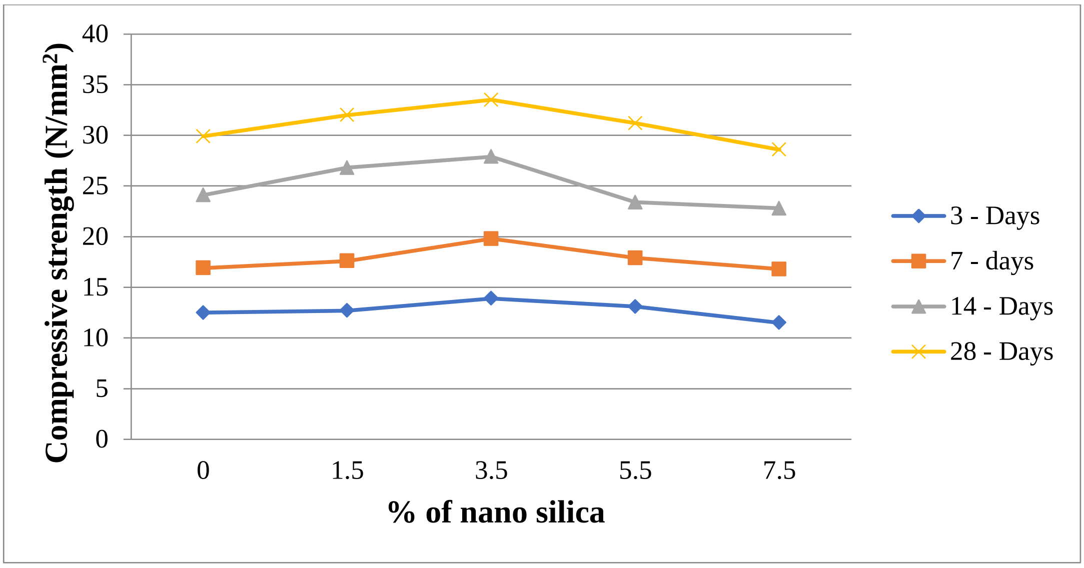
5.2 Using Blended cement

Table3 :Results for cement mortar by usingBlended Cement

Sl.No	% replacement ofnano silica	Description	3 days	7 days	14 days	28 days
1	0	P.C	12.5	16.9	24.1	29.9
2	1.5	$nSiO_2$	12.7	18.6	26.8	32
3	3.5	$nSiO_2$	13.9	19.8	27.9	33.5
4	5.5	$nSiO_2$	13.1	17.9	23.4	31.2
5	7.5	$nSiO_2$	11.5	16.8	22.8	28.6





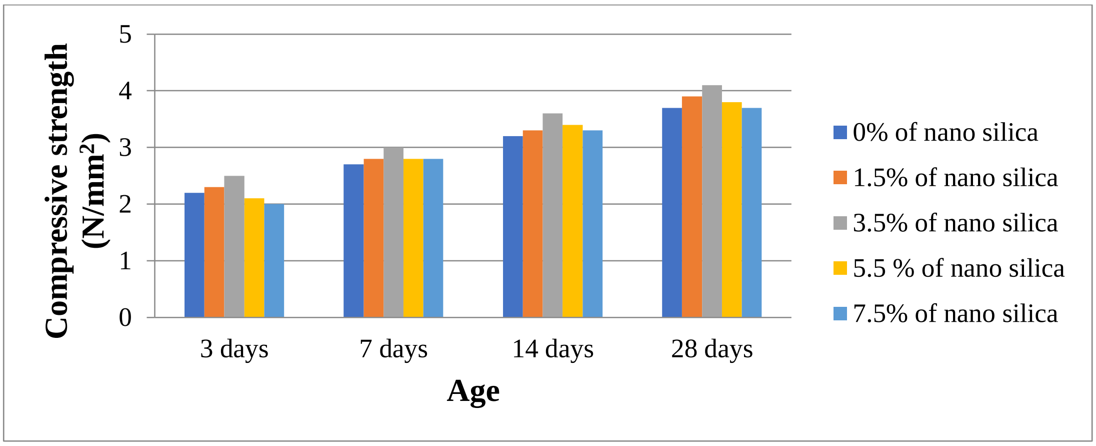


Graph 4: Cement mortar by using Blended Cement

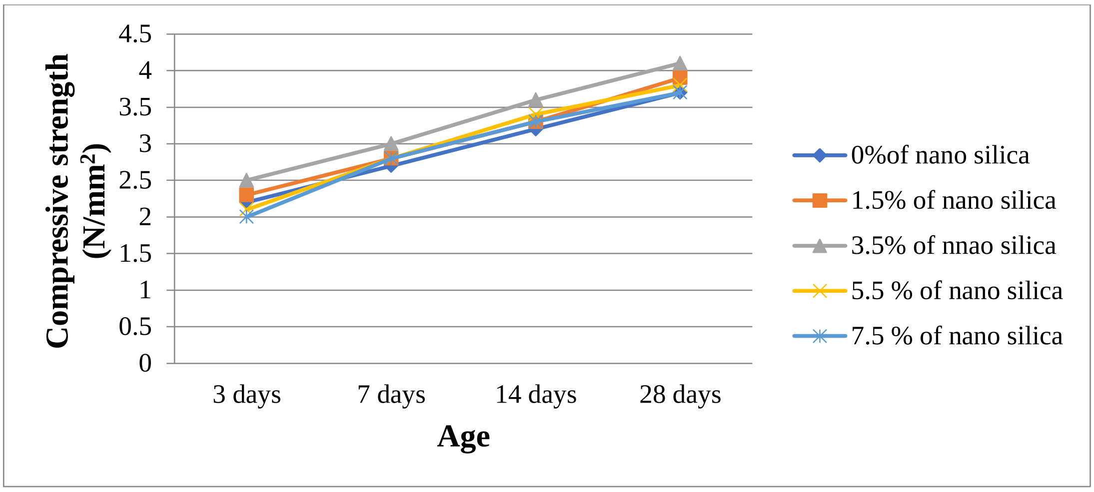
5.3 Using Blended Cement

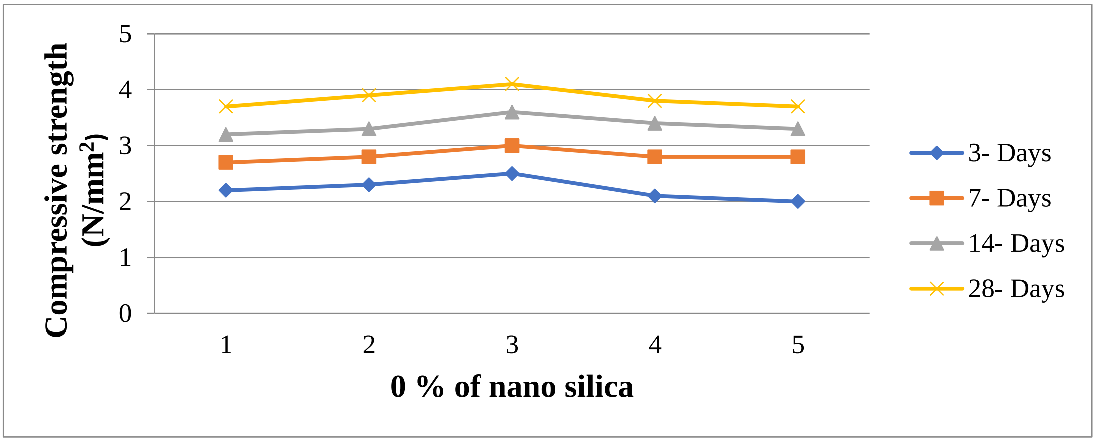
Table 4: Split tensile test result for cylinders by using Blended cement

Sl. No	% replacement of nano silica	Description	3 days	7 days	14 days	28 days
1	0	P.C	2.2	2.7	3.2	3.7
2	1.5	$nSiO_2$	2.3	2.8	3.3	3.9
3	3.5	$nSiO_2$	2.5	3.0	3.6	4.1
4	5.5	$nSiO_2$	2.1	2.8	3.4	3.8
5	7.5	$nSiO_2$	2.0	2.8	3.3	3.7



Graph5 : Split tensile test for cylinders by using Blended cement





6. CONCLUSIONS:

The objective of this study is to determine the strength of the materials by using the nano silica and also comparison with the Ordinary Portland Cement and blended cement for the cement mortar. Analyzing the results obtained from this investigation, the following conclusions are drawn.

1. The compressive strength of the OPC cement mortar is lower than the Blended cement mortar.

2. The strength will increase by using the increase percentage of the nanosilica.

3. Upto 3.5% replacement of nanosilica should increase the strength and at 5.5% and 7.5% of silica replacement decreases the strength.

4. Compressive strength increases with increasing the nanosilica contentupto the 3.5% of replacement by weight of the cement.

5. The consistency and setting time is different for the percentage increase of Nsio2.

6. To optimize the performance of nanosilica in OPC and Blended Cement.

7. Based on the mechanical properties results it can conclude that nanosilica can improve the mechanical properties strength.

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