An Experimental Study on the Effect of Nano- Silica Particles on the Properties of Concrete

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Abstract *- Concrete is the one of the powerful ingredient for construction field, this concrete can improved by adding some extra additives like nano powders which helps to increases the strength in the concrete, but nano powder of silica is very advantageous in reducing temperature effects and high hardness property, so it used in highly temperature condition as a coatings and paints, the requirement of journals by using nano silica powder in concrete is minimum. Improving concrete properties by addition of Nano particles have shown significant improvement than conventional concrete. Adding Nano materials in ordinary concrete can improve the performance of concrete including strength, toughness, durability, permeability, fire resistance and other properties. The application of Nano silica in concrete not only save the resources and energy but also protect the environment from the pollution with the reduction of waste material and reduction of CO2 emission. The influence of Nano-silica on various properties of concrete is obtained by replacing the cement with various percentages of Nano silica. In this present work nano silica used as a partial replacement for cement in the range of 0.5%, 1%, 1.5%, 2% weight of cement for M30 mix. Concrete cubes and cylinders have been casted. Laboratory tests are conducted to determine the Compressive Strength, Split Tensile Strength of Nano-silica concrete at the age of 7 and 28 days.*

Index Terms*- Strength, Nano Technology, Nano-Silica Powder, Nano Silica Concrete, Compressive Strength, Split Tensile Strength.*

I. INTRODUCTION

Nanotechnology is an emerging avenue of research having a potential impact on every domain of science and technology. There are number of definitions for nanotechnology given by many researchers. Drexler et al. defined as ‘‘the control of the structure of matter based on molecule-by-molecule control of products and by-products’’. Some researchers defined as ‘‘the understanding, control and manufacturing of matter on the order of nanometers (lesser than 100 nm) to create materials with fundamentally new properties and functions. For construction sector, nanotechnology can be defined as science of controlling the properties at nanometer scale which can make revolutionary changes in bulk material properties. The aim of the application of ultra-fine additives like nanosilica in cementitious systems is to improve the characteristics of the plastic and hardened material.

- *Uses of Nanomaterials in Construction Industry*

Construction industry among other industries follows the recent development of nanotechnology and tries to implement the development into itself. Use of nanoparticles in construction materials is getting popular day by day. With the use of nanoparticles, not only properties of material such that strength, durability but also photo-catalytic (Lack off et al., 2003), sensation to stress changes (Hui et al., 2004) properties would be gained to the concrete body. In recent years, many studies focusing on nonmaterial in construction materials have been conducted. Nanotechnology taking place in the literature of concrete and other cement base composites can be categorized into four groups: investigation and modification of nano-structure of CSH gel, providing controlled release of chemical additives into concrete mix, cement based composites including carbon nano-tubes, and cement systems including nanoparticles

- *Nano Silica*

The third particle that has the ability to drastically improve the properties of concrete is nano sized silicon dioxide, known as nano-silica. When utilized correctly, these nanoparticles can block water penetration; help to make the concrete denser, and also reduce the impact concrete has on the environment. To explain the usefulness of nano-silica, we need to go back to the basics of what composes concrete. A common misconception is that concrete and cement are two interchangeable words for the same exact material.

However, this is not the case. Cement is a construction material made from limestone, calcium, silicon, and a few other ingredients. Concrete on the other hand is a material that uses cement to bind together crushed stone, rock, and sand. In fact, it is the cement content in concrete that causes the harmful carbon dioxide emissions.

Figure No 1 Nano Silica

- *Objective of the Study*

The principle targets of the present research are as referenced underneath:

To examine the impact of nano-silica on the compressive Strength of concrete at 7, 28 days by replacing the cement with nano silica of 0.5%, 1%, 1.5%, 2% by weight of cement.

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To examine the impact of water cement ratio on nano-silica blended concrete.

II. MATERIALS AND METHODOLOGY

General

The materials such as cement, nano silica, and fine aggregate and coarse aggregate were used in the present work. The properties of above mentioned materials were studied and presented in this chapter. Further, the mix proportion, preparation of test specimens and methodology adopted for determining the properties of effect of nano- silica particles on the properties of concrete.

Materials Used

The materials such as cement, river sand, coarse aggregate and nano silica were used in concrete. The ordinary Portland cement was used as binder to make control mix.

Cement

Ordinary Portland cement (OPC) of 53 grade, satisfying the requirements of BIS 12269-2013 has been used to produce control mix. The physical properties of the cement were measured as per BIS 4031- 1988, the chemical properties of cement were analysed using the procedure prescribed by BIS: 4032-1985

W/C Ratio	Mix proportions (Kg/m3)				NS%	SP%
	C	W	FA	CA		
0.4	450	180	664	1180	0%, 1%, 1.25%, 1.5%, 2% & 3%.	0, 0.5, 0.75, 1, 1.25, 1.5
0.5	400	200	615	1205	0%, 1%, 1.25%, 1.5%, 2% & 3%.	0, 0.5, 0.75, 1, 1.25, 1.5

Table No 1Concrete mix proportions

	Top dia	Bottom dia	Height
Upper hopper	25 cm	12.5 cm	22.5 cm
Lower hopper	22.5 cm	12.5 cm	22.5 cm

Table No 2 the dimensions of cylinder are 15cm dia & 30 cm height.

III. RESULTS AND DISCUSSIONS

Compressive Strength

Compressive strength tests were conducted on cured cube specimen at 7 days and 28 days age using a compression testing machine of 200 KN capacities. The cubes were fitted at center in compression testing machine and fixed to keep the cube in position. The load was then slowly applied to the tested cube until failure.

Sl.no	Mix (days)	NS%	Cube Compressive strength (N/mm^2)
1	7	0%	24
		1%	27.12
		1.25%	26.16
		1.5%	27.54
		2%	28.26
		3%	28.92
2	28	0%	40
		1%	45.2
		1.25%	43.6
		1.5%	45.9
		2%	47.1
		3%	48.2

Table No 3 Compressive strength of concrete containing

NS for W/c = 0.4 at curing time: 7 days & 28 days

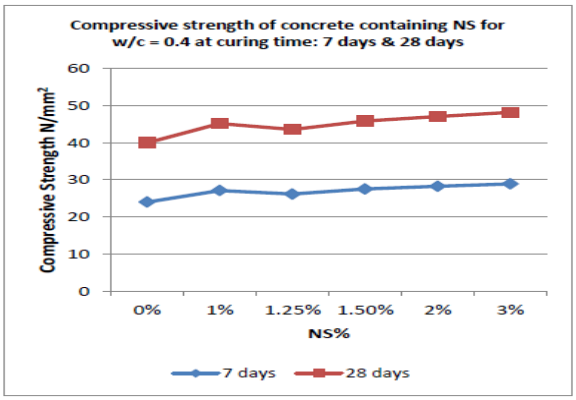

Figure No 2 Compressive strength of concrete containing NS for w/c = 0.4 at curing time: 7 days & 28 days

Sl.no	Mix (days)	NS%	Cube Compressive strength (N/mm^2)
1	7	0%	19.37
		1%	20.93
		1.25%	19.565
		1.5%	22.49
		2%	23.465
		3%	24.245
2	28	0%	29.8
		1%	32.2
		1.25%	30.1
		1.5%	34.6
		2%	36.1
		3%	37.3

Table No 4 Compressive strength of concrete containing NS for w/c = 0.5 at curing time: 7 days & 28 days

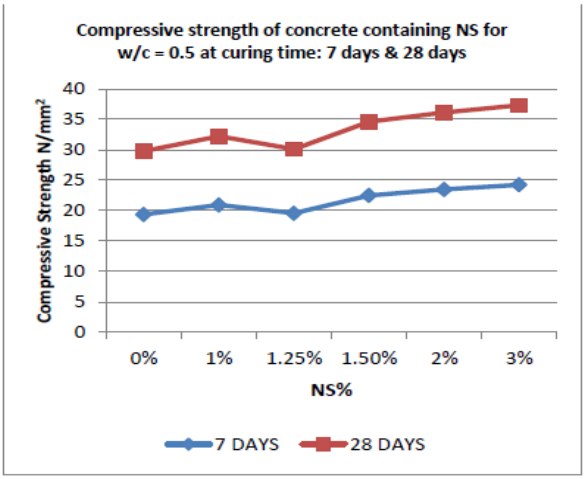

Figure No 3 Compressive strength of concrete containing NS for w/c = 0.5 at curing time: 7 days & 28 days

IV. SUMMARY AND CONCLUSIONS

In the study, Experimental Investigation on the Effect of Nano- Silica Particles on the Properties of Concrete as a partial replacement for cement on compressive strength and the results were compared with OPC.

Compressive strength is considered as the most important property of concrete as it can be an indicator for other properties. The variation of compressive strength at 7 and 28 days with NS content are presented in Figs. for different w/c ratios. For w/b = 0.4, it can be observed that the compressive strengths of concrete containing NS at 7 and 28 days were higher than that of control concrete for all mixes.

This can be supported by the fact that with smaller silica particles, the rate of cement hydration can also be enhanced due to the increase of the heat release by C3S-accelerated hydration rate. By adding NS over 1%, more improvements were observed at 7 days for NS-50 to reach the highest strength gain (18.3%) at 3%.
Beyond 3% the compressive strength reduces according to literature review data and this reduction in the

performance may be due to the excess of NS particles, causing no further chemical reaction, and hence the particles only act as fillers without any more contribution to compressive strength.

It can be noted that all concrete containing NS enhanced compressive strength compared to the control mix.

Overall, NS-50 was more beneficial for the formation of C-S-H gel than ordinary cement by achieving the best strength throughout this investigation. However, the enhancement achieved for w/b = 0.5 was better than that for concrete having w/b = 0.4, agreeing with the results of, who reported that NS particles are more efficient in lower cement content.

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