

Influence Of Nano-Silica On The Strength And Durability Of Self Compacting Concrete

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ABSTRACT:

Nano silica is a shapeless kind of silica clean for the most part gathered in sack house channels as side-effect of the silicon and Ferro-silicon creation. The task outlines critical physical and substance properties of Nano silica and its applications. Nano silica comprises of round particles with a normal molecule size of 150 nm and a particular surface territory of ordinarily 20m³/g. The compound and physical properties of this inorganic item are diverse when contrasted with different nebulous and crystalline silica poly transforms. More than 500.000 MT of Nano silica are sold to the building business worldwide and are utilized as a part of fiber bond, solid, oil-well boring, refractories, and even in polymers. Nano silica contains follow measures of overwhelming metal oxides and natural stores, which begin from characteristic crude materials. The primary field of utilization is as pozzolanic material for superior cement. It is now and again mistaken for raged silica. Nonetheless, the generation procedure, molecule attributes and fields of use of smoldered silica are largely not quite the same as those of silica fume. Concrete possesses special position among the cutting edge development materials. Concrete is a material utilized as a part of building development, comprising of a hard,

artificially idle particulate substance, known as total (normally made for various sorts of sand and rock), that is bond by bond and water. Nano silica in light of its extraordinary fineness and high silica content, silica rage is an extremely powerful pozzolanic material. Standard particulars for silica smolder utilized as a part of cementations blends are ASTM C1240, EN 13263. Silica seethe is added to Portland bond cement to enhance its properties, specifically its compressive quality, bond quality, and scraped spot protection. These enhancements come from both the mechanical upgrades coming about because of expansion of a fine powder to the concrete glue blend and in addition from the pozzolanic responses between the silica smoke and free calcium hydroxide in the glue. This task compresses about the correlation between the M60 concrete with Nano silica cement of same review. The Mix Design for concrete M60 review is being done according to the Indian Standard Code May be: 10262-1982. In this undertaking Nano silica is utilized as a simulated pozzolan and 6% 12% 18% is added to the heaviness of bond in concrete.

Catchphrases: Nano silica, channels, pozzolanic, concrete.

1.INTRODUCTION

Nano silica is a mineral admixture makes out of fine strong polished circles of silicon dioxide (SiO₂). Most Nano silica particles are under 1 Nanon (0.00004 inch) in width, by and large 50 to 100 times better than normal concrete or fly powder particles. Oftentimes called consolidated silica smolder, Nano silica is a side-effect of the mechanical make of ferrosilicon and metallic silicon in high-temperature electric curve heaters. The ferrosilicon or silicon item is drawn off as a fluid from the base of the heater. Vapor ascending from the 2000-degree-Cfurnace bed is oxidized, and as it cools consolidates into particles which are caught in tremendous fabric sacks. Preparing the dense smoke to evacuate contaminations and control molecule measure yields Nano silica. Nano silica, otherwise called Silica smolder is fine indistinct silica. Added to concrete at around 30kg/m³ it changes the rheology and responds with the bond hydration items to drastically enhance solid qualities, toughness and impermeability, enabling cement to be utilized as a part of courses at no other time conceivable.

At the point when pozzolanic materials are fused to concrete, the silica display in these materials respond with the calcium hydroxide discharged amid the hydration of bond and structures extra calcium silicate hydrate (C – S – H), which enhance solidness and the mechanical properties of cement. High quality solid alludes to solid that has a uniaxial compressive quality more noteworthy than the ordinary quality cement got in a specific district. High quality and superior cement are in effect generally utilized all through

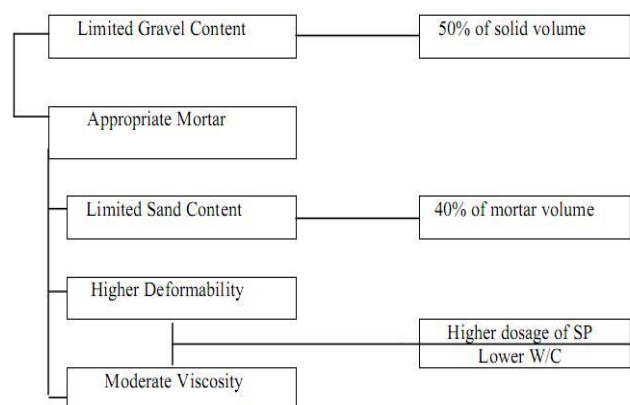
the world and to deliver them, it is important to lessen the water fastener proportion and increment the cover content. High quality solid means great scraped spot, effect and cavitation's protection. Utilizing high quality cement in structures today would bring about financial points of interest. In future, high range water diminishing admixtures (Super plasticizer) will open up new potential outcomes for utilization of these materials as a piece of establishing materials in cement to create high qualities, as some of them are make better than bond.

2.METHODALOGY:

Low water-powder proportion.

Utilization of super plasticizer.

The recurrence of crash and contact between total particles can increment as the relative separation between the particles abatements and after that inside anxiety can increment when concrete is disfigured, especially close obstructions.



segments to screen development security and auxiliary wellbeing.

The molecule pressing in cement can be enhanced by utilizing Nano-silica which prompts densifying

of the miniaturized scale and nanostructure bringing about enhanced mechanical properties. Nano-silica expansion to bond based materials can likewise control the corruption of the principal C-S-H (calcium-silicate-hydrate) response of cement caused by calcium filtering in water and in addition piece water entrance and along these lines prompt enhancements in sturdiness. Carbon nano tubes (CNTs) when utilized as an intermediary for polymeric concoction admixtures can strikingly enhance mechanical strength by sticking solid blends, that is, cementitious specialists and solid totals, and forestall split proliferation. Fuse of CNTs as split crossing over operators into non-beautifying earthenware production can upgrade their mechanical quality and lessen their delicacy, and in addition enhance their warm properties breadth. The key is the span of particles in light of the fact that the properties of materials are significantly influenced under a size of the nanometer (nm), 10⁻⁹ meter (m).

Low upkeep covering

Enhancing channel joining materials and strategies.

Better properties of cementitious materials

Decreasing the warm exchange rate of flame retardant and protection

Expanding the sound retention of acoustic safeguard

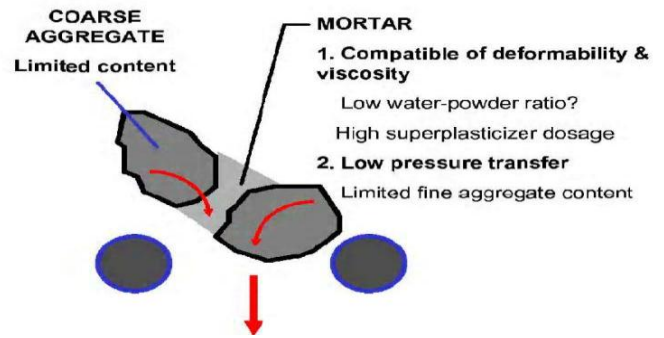
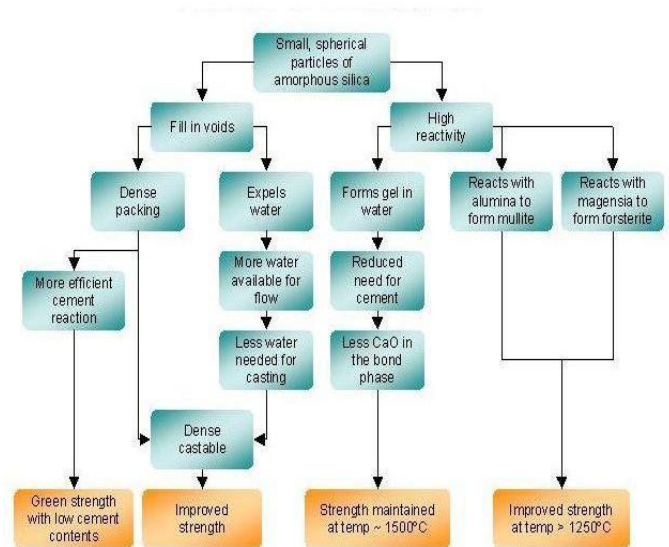


Chart -2: Nano Silica Properties



3.CONCRETE MIX DESIGN METHODS

The fundamental goal of solid blend configuration is to locate the most sparing properties to accomplish the want final products (quality, attachment, workability, strength) the proportioning f concrete depends on certain material properties of bond, sand, and totals. Solid blend configuration is fundamentally a procedure of bringing trials with specific extents. Techniques have been created to touch base at these extents

that will most monetarily accomplish final products. These techniques just fill in as a base to star and accomplish the final product on the least conceivable trials. The code hone for blend configuration IS-10262 unmistakably states following:

The essential presumptions made in blend configuration is that the compressive quality of workable cement, all things considered, represented by the water/concrete proportion. Another most helpful relationship pertinent to ordinary cement is that for a given sort, size and reviewing of totals, the measure of water decides its workability. In any case, there are different components which influence the properties of cement, for instance the amount and nature of bond, water and totals; clumping; transportation; setting; compaction; curing; and so forth along these lines, the particular connections that are utilized as a part of proportioning concrete blends ought to be viewed as just as the reason for trial, subject to adjustments in the light of encounters and for the particulars materials utilized at the site for each situation.

Distinctive blend plans strategies causes us to arrive the blend that will give us required quality, workability, attachment and so on these blend outline techniques have same ongoing themes in touching base at extent however their strategy for estimations is unique.

BASIC STEPS IN MIX DESIGN:

To find the target mean strength.

To determine the curves of cement based on its strength.

To determine the water/cement ratio.

To determine cement content.

To determine fine and coarse aggregates proportions

We will now follow above steps and solve a mix design problems by different methods

MIX DESIGN METHODS

IS technique

DOC technique

ACI technique

The RRL technique

IS technique:

The BIS prescribes planning blends in view of locally accessible concrete and different materials. These rules are relevant for ordinary cement (not exactly around 45 MPa) blend outline. Utilization of hole evaluated totals, different admixtures, and pozzolans was past the extent of this detail. The plan ventures for blend proportioning were as under:

1. The objective normal compressive quality (f'_{ck}) at 28days was controlled by utilizing condition 1:

$$f'_{ck} = f'_{ck} + k_s$$

Where,

f_{ck} = trademark compressive quality at 28 days,

s = standard deviation of compressive quality,

t = a measurement, contingent on the acknowledged extent of low outcomes and the quantity of tests.

2. The water bond (w/c) proportion was looked over an observational relationship (summed up diagram or charts in light of the quality of concrete or quickened quality of cement) for the given 28-day target mean quality. The w/c proportion was checked against the restricting w/c proportion to fulfill the sturdiness prerequisites.

3. Air content, measure of captured air in new concrete, as level of volume of cement, was assessed in view of the ostensible most extreme size of aggregate (NMSA).

4. At first, water content, as mass (kg) per unit volume (m^3) of cement, was chosen in view of the objective quality. At that point, the at first decided water content was balanced for workability conditions relying on the compacting component and sorts of totals.

5. Sand content, as level of aggregate total volume, was chosen in light of the NMSA and the objective quality. At that point, the at first decided sand content was balanced for workability conditions relying on the sand reviewing zone, w/c proportion, and kind of totals.

6. The bond content was computed from the w/c proportion and the water content. The bond content, consequently figured, was then checked against the base concrete substance to fulfill the toughness necessity.

7. With the amounts of water and bond per unit volume of cement and the level of sand in the aggregate total effectively decided, the coarse and fine total substance per unit volume of cement was computed from the accompanying conditions, individually:

Computation for C.A. and F.A

$$V = [W + (C/S_c) + (1/p) \cdot (f_a/S_{f_a})] \times (1/1000)$$

$$V = [W + (C/S_c) + \{1/(1-p)\} \cdot (c_a/S_{c_a})] \times (1/1000) \text{ where,}$$

V = supreme volume of new solid, which is equivalent to net volume (m^3) short the volume of captured air,

W = mass of water (kg) per m^3 of cement

C = mass of bond (kg) per m^3 of cement

S_c = particular gravity of concrete,

(p) = Ratio of fine total to add up to total by supreme volume,

(f_a) , (c_a) = add up to mass of fine total and coarse total (kg) per m^3 of cement individually,

Sfa, Sca = particular gravities of immersed surface dry fine total and coarse total individually.

8. At long last, water content was balanced in light of the assimilation and the flow dampness substance to create likeness soaked surface dry state of the totals.

The IS strategy experiences following confinements:

1. The IS strategy prescribes 35 % sand content by outright volume for zone II sand with remedy of +1.5 % for zone I and – 1.5 % for zone III. These zones have wide range and this amendment isn't satisfactory to accomplish a durable blend. Here and there an amendment might be required notwithstanding when fine total changes from upper side to bring down side of a specific zone.

2. Despite the fact that sand content is balanced for bring down water concrete proportion there is no immediate change for bond content. As talked about before, the bond particles act, as fines in concrete and wealthier lesser fine total when contrasted with more slender blends. A blend in which bond content has been brought down by utilization of plasticisers may require higher sand substance to enhance union.

3. The IS strategy gives distinctive tables for deciding sand content for concrete up to M 35 review or more M 35 review. There is a sudden change in sand content from 35% to 25% in the two tables when moving from M 35 review

cement to M40 review concrete. The change might be advocated to represent higher concrete substance however it ought to be continuous in nature.

4. The IS strategy considers compaction factor as measure for workability, to figure the water request. Compaction factor may not accurately speak to workability and the changed IS 456 2000 has avoided compaction factor as a measure of workability. It prescribes utilization of droop as a measure for workability. Connection amongst droop and compaction factor is hard to institutionalize. blends frequently require

4. TESTING OF MATERIALS

Every one of the fixings utilized for readiness of the solid, are completely tried for their quality and physical properties in an all around prepared research center joined to the plant for compliance to pertinent Indian standard codes. The dampness test decides the water be included for the extent of blend. The sand being utilized is gone through the automated sieving framework, before encouraging for blend. Trial blends did and tried to guarantee that every single group of solid leaving the plant meets the parameters of customer's prerequisites. The sand being utilized is gone through the automated sieving framework, before sustaining for blend.

TEST ON NANO SILICA

Particular gravity of Nano silica:

Point: To decide the particular gravity is ordinarily characterized as the proportion between the heaviness of given volume of material and weight of an equivalent volume of water. To decide the particular gravity of Nano silica Mechanical assembly:

Particular gravity bottle Weight adjust Lamp oil Nano silica Water Technique:

Weight perfect and dry particular gravity bottle.

Take the perusing as W1.

Presently fill the jug with water to overflow and weight it. Take the perusing as W2.

Supplant the water with lamp fuel and weight it. Take the perusing as W3.

Clean the particular gravity jug and fill the 1/3 of the container with Nano silica and weight it. Take the perusing as W4.

Add lamp oil to the jug, now the container is loaded with Nano silica and lamp oil, weight it. Take the perusing as W5.

The particular gravity of Nano silica and lamp oil is figured by following equations

Particular gravity of lamp oil = $(W3-W1)/(W2-W1)$

S.G. of Nano silica = $(W4-W1)/(W3-W1)(W5-W3)$
×S.G. of lamp oil

Perception and figuring:

Weight of discharge bottle, W1 = 34.4grms

Weight of container + water, W2 = 83.55grms

Weight of container + lamp oil, W3 = 74.24grms

Weight of Nano silica(1/3), W4 = 53.470grms

Particular gravity of lamp oil = $(W3-W1)/(W2-W1)$

$=(74.24-34.4)/(83.55-34.4)$

= 0.8105

S.G. of Nano silica = $(W4-W1)/(W3-W1)(W5-W3)$
×S.G. of lamp oil

$=((63.470-34.4))/((74.24-34.4)-(95.84-53.47)) \times 0.8105 = 2.21$

TEST ON CEMENT

Particular gravity test:

Point:

To decide the particular gravity is ordinarily characterized as the proportion between the heaviness of given volume of material and weight of an equivalent volume of water. To decide the particular gravity of concrete.

Mechanical assembly:

$$\text{Particular gravity of lamp oil} = (W3 - W1) / (W2 - W1)$$

Particular gravity bottle.

$$\text{S.G. of concrete} = (W4 - W1) / (W3 - W1)(W5 - W3) \times \text{S.G. of lamp fuel}$$

Weight adjust.

Lamp oil.

Perception and figuring:

Concrete.

$$\text{Weight of discharge bottle, } W1 = 34.4\text{grms}$$

Water.

$$\text{Weight of jug + water, } W2 = 83.55\text{grms}$$

Strategy:

$$\text{Weight of jug + lamp fuel, } W3 = 74.24\text{grms}$$

1. Weight perfect and dry particular gravity bottle. Take the perusing as W1.

$$\text{Weight of bond (1/3), } W4 = 63.470\text{grms}$$

2. Presently fill the jug with water to overflow and weight it. Take the perusing as W2.

$$\text{Particular gravity of lamp fuel} = (W3 - W1) / (W2 - W1)$$

$$= (74.24 - 34.4) / (83.55 - 34.4)$$

3. Supplant the water with lamp fuel and weight it. Take the perusing as W3.

$$= 0.8105$$

4. Clean the particular gravity container and fill the 1/3 of the jug with bond and weight it. Take the perusing as W4.

$$\text{S.G. of bond} = (W4 - W1) / (W3 - W1)(W5 - W3) \times \text{S.G. of lamp fuel}$$

$$= ((63.470 - 34.4) / ((74.24 - 34.4) - 63.47)) \times 0.8105$$

$$= 3.154$$

Result:

$$\text{Particular gravity of taken bond test is} = 3.154$$

5. Add lamp fuel to the container, now the jug is loaded with concrete and lamp oil, weight it. Take the perusing as W5.

6. The particular gravity of concrete and lamp fuel is computed by following equations

5. EXPERIMENTAL INVESTIGATION AND RESULT:

5.1 Introduction

The exploratory examination comprises of landing at reasonable blend extents that fulfilled the crisp properties of self compacting concrete according to EFNARC details. Standard solid shape molds of 150mm x 150mm x 150mm made of cast press were utilized for throwing standard 3D squares. The standard molds were fitted with the end goal that there are no holes between the plates of the molds. In the event that there are any little holes they were loaded with mortar of paris. The molds were then oiled and kept prepared for throwing. After 24hrs of throwing, examples were demoulded and exchanged to curing tank where in they were submerged in water for the coveted time of curing. The program comprises of throwing and testing of 40Mpa Self Compacting Concrete with increases of nano silica and without nanosilica. A aggregate of 7 batches were made, out of which 1 batch is of typical SCC i.e., without nano silica, 3 batches of nanosilica (16% nano content) with augmentations of 1%, 1.5% and 2% bwoc and 3 batches of nano silica (30% nano content) with augmentations of 1%, 1.5% and 2% bwoc. The blend extent for 40Mpa Self compacting concrete was outlined by utilizing adjusted nan su technique. Water diminishing admixtures are included into blends necessity, till the coveted properties are displayed by them. 15 cubes were threw in each clump, out of which 6 cubes of each cluster are tried for compressive quality for 28 days, 3 cubes of each bunch are tried for 5% H₂SO₄ (sulphuric corrosive), 5% HCl (Hydrochloric corrosive) and Sorptivity test for strength viewpoints.

The principle target of this venture is to think about the quality and toughness impacts of Nano silica incorporations in Self Compacting Concrete with different rate increases. The exploratory examination comprises of touching base at appropriate blend extents that fulfilled the new properties of self compacting concrete according to EFNARC particulars. Standard solid shape molds of 150mm x 150mm x 150mm made of cast press were utilized for throwing standard blocks. The standard molds were fitted with the end goal that there are no holes between the plates of the molds.

MATERIALS USED

S. No	Grade of Concrete	Type of Concrete	% of Nanosilica added by BWOC added	No. of cubes cast 150x150x150mm
1.	40Mpa	SCC without Nano silica	-	15
		SCC with Nano silica (16% nano content)	1%	15
			1.5%	15
			2%	15
		SCC with Nano silica (30% nano content)	1%	15
			1.5%	15
			2%	15
Total Specimens				105

- The different materials used in this investigation are
- 53 Grade Ordinary Portland cement
- Fine Aggregate
- Coarse Aggregate

Fig -5: V-Funnel equipment

- Super Plasticizer (CONPLAST SP430)
- Fly ash.
- Water
- Nano Silica (16% and 30% nano content)

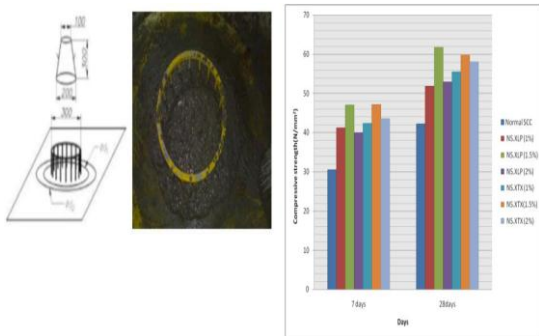


Chart -5: Graph between Sorptivity Coefficient and without nano silica

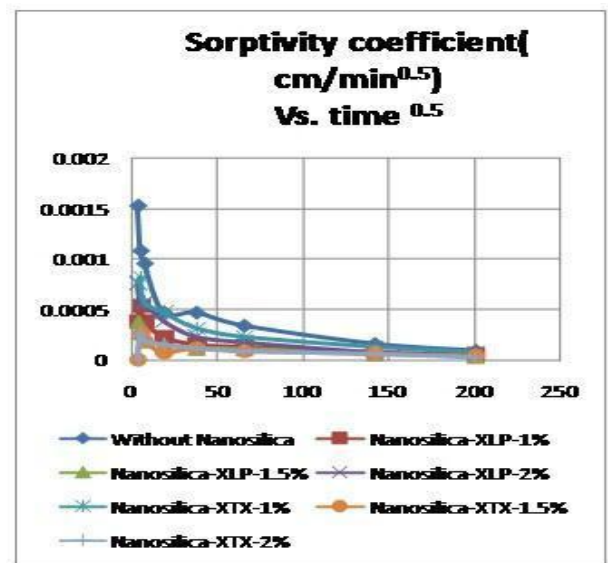
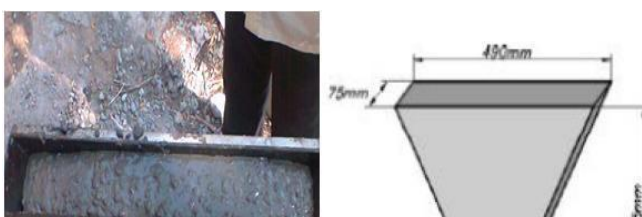


Table -2: Average Compressive Strength of SCC with and

Grade	Compressive strength (Mpa)		%Increase in compressive strength(Mpa)	
	7 days	28days	7days	28days
Normal SCC				
NS.XLP (1%)	30.51	42.3	0	0
NS.XLP (1.5%)	41.19	51.86	34.99	22.60
NS.XLP (2%)	47.05	61.74	54.21	45.96
NS.XTX (1%)	39.93	52.98	30.88	25.25
NS.XTX (1.5%)	42.31	55.48	38.66	31.16
NS.XTX (2%)	47.11	59.7	54.40	41.13
NS.XTX (2%)	43.62	58.12	42.96	37.40

time

Table -1: Details of specimens cast



From the charts it is watched that Initially there is tad increment in water retention in all the clusters however following 14 days it is watched that there is decrease.Out of three examples in all the clumps just a single or two examples are demonstrating a negligible increment in weight.Nano augmentations in SCC are practically impermeable, as there is no hairlike suction. This is may be because of

fill of nano materials into the pores.There is no much examination of coefficient of sorptivity

between the different nanoadditons, however 2% Nano XTX expansion has less coefficient of sorptivity when contrasted with alternate sorts.

6.CONCLUSIONS

The present work manages understanding the impact of nano silica incorporation on quality and sturdiness properties of self compacting concrete. In the present examination 40Mpa SCC was produced in view of altered nansu technique and

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