Self-compacting Concrete Using Nano Silica: An Experimental Study

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Abstract- Now a days Self-Compacting Concrete is the most common used concrete for construction now a day, Preparation of Self Compacting Concrete by addition of SP gives good results. Self-Compacting Concrete helps in reduction of man work at site. The void space in the concrete will not be reduced by using the SCC. For this purpose, partial replacement of Cement by NS Powder into the SCC helps in reducing the Void Space and concrete density will be increase. So, by the increase in concrete density and Strength of the concrete will also increases.

The present work deals with additions of nano-silica powder to Cement as a partial replacement to Cementous material as dosage by pf 2.5%,3%,3.5% respectively by the gauged cement and based on early research M_{20} grade concrete has been taken for the present study. Optimum Composition containing of SCC+ nano-silica powder was taken, in which compressive strength were increased to 6% respectively compared to the Nominal concrete. The advance of nano material is clearly seen in the Scanning Electron Microscope images showed in this journal paper. And the analysis has been taken and the presence of nano-silica and with particle shape and size are mentioned, nano-silica Powder is introduced into the concrete improves the interfacial surface transition zone area in between the Cementous material particles. The density of the concrete optimum specimens was decreased by 0.5% relative to the Nominal Concrete.

Therefore, Imbedding nano-silica powder to nominal Cement show a significant increase in compressive strength. SEM (scanning Electron Microscope) analysis evidence the direct involvement of nano-silica in the region of specimen.

Key words: self-compaction concrete, compressive strength, nominal concrete, void space, (SEM) Scanning electron Microscope, density, nano-silica Powder

Introduction

Nominal Concrete is a composite material mixture of cement, fine aggregates, coarse aggregates and water sometimes its mixed with admixtures like accelerators and retarders. Self-compaction concrete was first introduced in the year of early 1988 to achieve self-compaction by its using its own weight and reducing the void space in between the particles and increasing the durability in concrete structures. Since then, the advancement in innovation and investigations have been carried out in Self-compaction concrete, this type of concrete has been used in practical in large, mass concrete structures in Japan, Investigations was carried out to establishing the standard mix-design method and self-compatibility methods. Self-Compaction Concrete has higher compressive strength due to closely packed particles present in the concrete, due to this nature the construction industry focusing on the time and optimized solution for the faster in casting and achieving better results comparing with nominal concrete and have greater impact in the concrete era. Therefore, keeping economics in picture SCC in cumulative is more economical, strength and durability building structures. The use of large portion of cement results in increases in CO_2 emissions and risk in duplation of ozone layer and increases in green house effects. By using nano silica partially to reduce the cement content in concrete mix. In the previous literature implies the European Federation of Specialist Construction Chemicals and Concrete Systems. SCC can be defined as well as concrete that is able to flow under its own self weight under the gravitational force and completely fill the formwork without any voids, even in the high and heavy dense reinforcement without any external compaction like pin vibrator or surface vibrator ect., and maintaining the homogeneity of the concrete in every section of casting. SCC It is also called Super-Workable Concrete and high workability Concrete SCC and can be controlled by appropriate and specific dosage of plasticizer and superplasticizer. In this study imbedding nano-silica in to the concrete, partially replacing cement to the nano silica and concrete prepared. In this study the properties of nano-silica are mentioned the results are compared with that nominal or traditional concrete. The compression has been done by the Compressive strength of both nominal and SCC. and concrete with addition of nano-silica were determined and compared with results of nominal or traditional concrete of M_{20}. The principle stresses are compressive cube samples were obtained and tested in compressive testing machine in order to meet the minimum compressive strength of prepared specimen. economic benefits are likely to more in Self Compacting Concrete when compared to nominal or normal concrete. Self-Compaction Concrete is economical due to the flowable in nature and it is easily compacted due to the super plasticizer in it and feasible technical solution present in it. The use of SCC result in less maintenance and durable life for the structure. To achieve these effective results from conventional or nominal concrete to self-compaction concrete.

CONCRETE AND SUSTAINABILITY

Concrete is a unique material and it is very easily casted and mȯunded in different shapes and sizes in construction. The current construction there is a biggest hassle with the well compaction concrete as we know 5% of voids reduces 30% of actual strength of the concrete so it's a biggest challenge for the skilled labor so by adopting this kind of technique like SCC we can achieve the complete compaction and in other hand we can achieve the targeted strength and practices are based on the consumption of building materials, resulting not wasting the resources, The sustainable development of the cement concrete structures.

Degree of dispersion of cement in water that is water cement ratio is largely depends on the flowable of concrete and excess of water can occur segregation in concrete, hydration of cement behavior and properties of the hardened cement. Factors such as water cement ratio, has early hydration, water reducing admixture agents and mineral admixture agents are added determine the degree of flocculation in the cement paste. As we understand the high strength concrete depends upon water cement ratio. The strength w/c ratio rule holds good for concrete strength that we can determine by workability test. Low water cement ratio is also required for low permeability of concrete and to give good strength results and to give good hold like short creating and which is vital for high durability. low water cement ratio ensures high strength and low permeability or high durability according to the IS code. to ensure the workability of concrete low water cement ratio will require high cement content as well as strength but very low in workability due to the more of compaction is required and more voids can be occurred.

SELF CONSTRICTING CONCRETE

The British Standard describes "SCC is the concrete that is capable to flow under its own weight and compacted by gravity, fill the formwork corners and reinforcement given covering to the section like beams and columns ducts, etc.,

Marinating the homogeneity of the concrete. SCC exhibits following properties in its plastic state. It has the ability to flow into every corner of the formwork and completely all spaces in the dense reinforcement and while maintaining homogeneity and ability of concrete mix to pass through obstacles like narrow sections in form work like curved section zig Zac section, closely spaced reinforcement without getting blocked by interlocking of course aggregate particles. Segregation resistance of self-compaction concrete is its capability to retain homogeneity in the distribution of ingredient in fresh concrete mix in both static and dynamic moving condition i.e., workability during mixing, transportation and placing and finishing.

The mechanism behind the SCC when water is added into the cement the past becomes cohesive in nature the particals attracts each other. The super plasticizer is used. It's a special type of chemical that reputation action takes place and the Cementous particles and that losses its cohesive in nature and the cement particles ripples to each other, then the sticky nature changes into the form cohesionless past this phenomena occurs due to the agents are added into the Cementous particles due to this the cement starts loses its shape and starts flow like a liquid this is called flowing or compacting by its own weight this turn into self-compaction concrete.

NANO TECHNOLOGY IN CONCRETE

Nanotechnology is rapidly becoming the Industrial revolution of 21st century. It is known that "Nano" is a Greek word and means 'dwarf'. It's a common word for everything which is smaller than 1Micron or 1 Million of a millimeter where 1 Micron is 1000 Nanometer. Nano technology helps in provide the filling in between the Cementous material that can increase the density in the form of siliceous material and strength to the concrete by adding the agent. Cement is primary structural material by addition of Nano Technology it helps as a smart functional material. Nano-silica has been added in order to increase the compressive strength, low permeability and reduces shrinkage. Cement particle size range bigger than few nano-meters to a maximum of about one hundred micro meter. In the case of Nano silica its ranges from 5 micro meter. the Properties of ordinary Portland cement like low shrinkage value, nano-silica powdered form reacts with liberated Calcium hydroxide from the hydration of cement that is OPC to form additional hydrated products like calcium silicate hydrate. Calcium silicate hydrate is main product of OPC it is primarily responsible for strength of bougs compounds comes in picture in cement-based materials. Chemical composition of OPC contains 17 to 27% of Silica. So, by addition of 2 to 3% of Nano Silica powder may help in increase in the strength of the concrete. Incorporation Nano silica powder in concrete mix leads to several benefits such as improves in Compressive strength, durability of concrete, chemical attack resistance, segregation resistance, permeability and water absorption. of cement's reaction with water as a function of temperature, water/cement ratio, and grain size because the reactions occur in the Nano-scale pores of the cement.

Objectives

The objective of present study is to find out the influence of the imbedded of Nano silica partially replacing cement. Nano silica is added in different dosages to study the variation in the compressive strength of concrete. 2%, 3% of Nano silica are adopted as replacement by weight according to the mix design of M_{20} grade. Cube moulds are casted for the purpose of testing. Specific objective of the study is:

- To find the workability aspects of Self Compacting Concrete and Nano Silica Powder concrete.
- To decrease the permeability and to reduce the shrinkage in self compacting concrete and finding out the right workability for construction work.
- To reduce the shrinkage in Self Compacting Concrete.
- To know the influence of Nano Silica Powder on the Strength Characters of Self Compacting Concrete.

Scope

The scopes of present work is increase the density as well as increase the compressive strength of the self-compaction concrete by adding nano-silica. Effect of Nano silica on the compressive strength of the self-compacting are studied and further modifications can

be done. Mix design of M20 grade is chosen to increase its strength and reduce shrinkage. Comparison of compressive strength between ordinary self-compaction concrete with SCC of Nano silica powdered form is down.

Experimental Procedure

The present procedure deals with the evolution of self-compaction concrete using Nano-silica powder. It also involves the study of properties of concrete compressive strength. Cement is partially replaced with Nano-Silica powder of dosages in standard grade of M20, which was designed in accordance with IS:10262-2009 (For Nominal Concrete) and Nansu Method following EFNARC Guidelines for SCC. We have chosen mix design of M_{20} Grade, in order to increase the compressive strength of the self-compacting concrete. The study involves Casting and Testing of specimen's cubes. The concrete lab available at St. Martin's Engineering College is used for the project. The workability test equipment's are used for filling ability and passing ability.

Table:1 Properties of Fine Aggregates

S.No.	Property	Result
1	Specific gravity	2.61
2	Fineness modulus	2.8
3	Bulk density(loose)	15.75KN/m^3
4	Grading of sand	ZONE-II

Coarse Aggregate

Coarse aggregates of nominal size 20 mm,12 mm, 10mm and 8mm, obtained from the local quarry confirming to IS: 10262:2009. The properties of coarse aggregates are shown in Table No.2.

Table:2 Properties of Coarse Aggregate

S. No.	Property	Result
1	Specific Gravity	2.6
2	Bulk Density	15.8KN/m^3
3	Water Absorption	0.3%
4	Fineness Modulus	7.2

Admixture

Admixture plays a vital role which makes SCC possible. The admixture used in this experiment is conplast SP430 (a polycarboxylate based superplasticizer).

Features & Benefits:

- Reduces setting time depending on the dose and ambient temperature
- Improves the workability of the concrete
- Reduces water cement ratio less of segregation
- Helps to achieve high early strength, hence reduces setting time required for removal of shuttering in time
- Ordinary Portland cement can be used thereby reducing cost

Observation and Calculations:

Fineness of cement = W1+W2+W3/ avg x10= weight retain on sieve/total weight

The initial setting time of the cement sample is found to be 33 minutes

The final setting time of the cement sample is found to be 210 Minutes

TESTS ON FINE AGGREGATE

Sieve Analysis

The properties of fine aggregate are shown in Tables below.

Weight of sand = 1000gms

Weight of pan = 814gms

Weight of pan +sand = 1814gms

Table:3 Sieve Analysis Results

S.No.	Sieve Size (mm)	Percent Retained	Cumulative % Retained	Percentage Passing
1	4.75	4.91	4.91	95.09
2	2.36	3.24	8.15	91.85
3	1.18	8.47	16.62	83.38
4	600	26.03	42.60	57.38
5	300	32.50	75.10	24.90
6	150	21.20	96.30	3.70

Fine aggregate is allowed to pass through the 4.75mm sieve and retain on 150microns sieve.

Flow Table

Flow table test is performed to determine the consistency of flow the concrete mix on the table. To perform the test, the apparatus is first made wet and then placed on a level, firm surface. Then a cone is placed on the flow table, concrete is filled into the cone in two layers. As it is a self-compacting concrete, compaction is not needed. Wait for 30seconds and remove the cone gently at a height of 40mm, allowing the concrete to flow on the table. confirming to IS: 1199-1959. The measured diameter of flow of concrete are as follows:

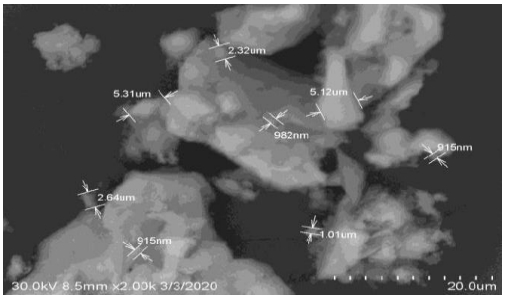
Table 4: Flow Table Results

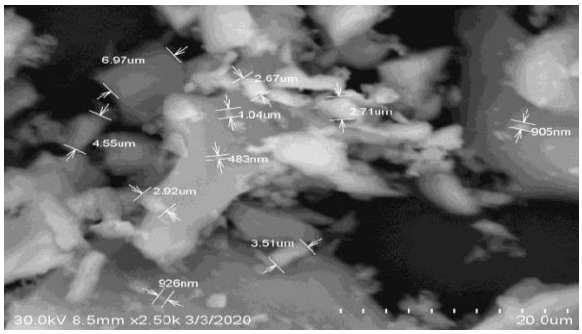
S.No	Description	Diameter of Flow	
1	SCC	48	48.5
2	SCC 2.5%	48	48.5
3	SCC 3%	47	48.4
4	SCC 3.5%	47.4	47.8

The L-Box should be filled by the concrete up to its 1/3rd

The concrete flows through the L-Box by its self-weight. The

Conclusions





SAMPLE 3: CEMENT +NANO SILICA

The main conclusions of this project are:

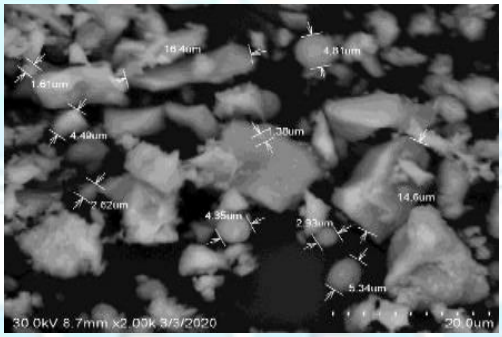
As we compare with nominal concrete Compressive strength with NS dosage of 7% has increased for 7 and 28 days respectively compared to normal.

As we compare with nominal concrete the workability of the concrete along with Nano-silica powder has decreased.

As we compare with nominal concrete, Due to Decrease in the quantity of cement, the concrete becomes economical and eco-friendly. Trial and error method was been used to design the SCC mix because there is no standard method for SCC in any institutes and concrete mix plants.As we compare with nominal concrete SCC do not depend in a single test, but it depends in all of the four tests and it must pass all of them to be called Self-compacting concrete.we compare with nominal concrete When compared with normal concrete self compaction concrete shows a significant increase due to well compacted as density increases in concrete strength also increases. SEM results shows that Nano-Silica helps in filling the voids spaces between the cement particles and helps in increasing the density of the concrete. If the density of the concrete increases then the compressive strength of the concrete also increases.

time taken by the concrete to reach the end of L-Box is tabulated below.

SAMPLE 1: CEMENT



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