An Experimental Analysis on Self Compaction Concrete Using Nano Silica

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Abstract- In this study, the mechanical properties of concrete composites containing Nano silica were investigated to produce more flexible and high-strength concrete. For this purpose, the different content of Nano-silica powder was added to concrete. The mechanical properties and the morphology of the sample were investigated. The mechanical properties such as flexural, tensile and compressive strength were significantly improved by incorporating the Nano-silica.

Optimum composition containing 2.5 wt. % to 3.5 wt. % of nano silica was obtained, in which the tensile strength, compressive strength and flexural strength were expected increase for 0.25% to 1.28% respectively compared to the next concrete. Scanning Electron Microscope images showed that introducing the nano-silica into concrete improved the interfacial transition zone in between the cement particles.

When SCC compared with Nominal Concrete, there is significant increase in workability and compressive strength. And also Normal SCC (without NS) is compared with Different small dosages of SCC with NS powder, there will be a significant increase in strength.

Indexed Terms- Self Compacting Concrete, Filling ability, passing ability.

I. INTRODUCTION

Concrete is a composite material made up of cement, sand, water and sometimes admixtures. Self-compacting concrete was first developed in 1988 to achieve durable concrete structures. Since then, various investigations have been carried out and this type of concrete has been used in practical structures in Japan, mainly by large construction companies. Investigations for establishing a rational mix-design method and self-compatibility testing methods have been carried out from the view point of making self-compacting concrete a standard concrete. The use of Self Compacting Concrete with significantly higher compressive strength of concrete is on increasing trend in the construction industry and is being seen as an optimized solution considering the economics, strength and durability required for special structures.

Cement is the most active component of concrete usually has the greatest unit cost, its selection and proper use are important in obtaining economical concrete and also concrete of desired properties. The use of large quantities of cement results in increasing CO2 emissions and as a consequence of the greenhouse effect. One of the methods to reduce the cement content in concrete mixes is the use of Nano materials. The properties of concrete in hardened state such as strength and durability are affected by the mix proportions and grading which results in particle packing. A part from individual symposium papers, several publications have been produced by some committees, such as "EFNARC Specifications and Guidelines for Self-Compacting Concrete" and "The European Guidelines for Self-Compacting Concrete".

EFNARC stands for The European Federation of Specialist Construction Chemicals and Concrete Systems. SCC can be defined as a concrete that is able to flow under its own weight and completely fill the formwork, even in the presence of dense reinforcement without any compaction, while maintaining the homogeneity of the concrete. SCC can also be known as Super-Workable Concrete. The high workability is one of the crucial properties for SCC and can be controlled by appropriate dosage of superplasticizer.

In this project an attempt is made to study the replacement of cement partial by addition of Nano-Silica in the properties of concrete prepared. And to study the properties of addition of Nano Silica to concrete and the results are compared with that pf traditional concrete. Compressive strength, tensile strength of concrete with addition of Nano-silica were determined and the results were compared with the traditional concrete. 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. The long-term economic benefits are likely to more in Self Compacting Concrete when compared to normal concrete. Self-Compacting Concrete is economical product, provide a feasible technical solution, or combination of both. The use of SCC is likely to result in less maintenance and longer life. To achieve these results from conventional concrete to self-compacting concrete we will have to revive the designing of structures by encouraging use of self-compacting concrete

II. PROBLEM STATEMENT

The majority of concrete cast required compaction to ensure that the development of adequate strength and durability. Generally, the purpose of compaction of concrete is to achieve the highest possible density of the concrete. Dense microstructure of concrete will results in low permeability, high strength, high resistance to chloride and sulfate attacks, low carbonation, and improved durability. Insufficient compaction will lead to the formation of voids, which results in negative impact on the physical and mechanical properties of concrete. Inclusion of voids will also influence the protection of the embedded steel reinforcement. Compaction of concrete is done manually by using vibrators in construction site. However, compaction will be difficult to be carried out at conditions as follows:

- Large concrete casting areas.

Presence of congested reinforcement

Inaccessible areas and spaces, etc.

The concrete floor slabs in factories and commercial buildings are of large areas and often subjected to continuous static and dynamic loadings. Self-weight is considered as static loading, while vibrations and impact loadings can be categorized as dynamic loadings. The loadings are usually induced by storages, containers, machineries, and heavy vehicles that present in the factories and commercial buildings. Hence, the concrete slabs have to exhibit good fatigue and impact strength to prevent failure in fatigue.

SCC will be suitable in the construction of industrial concrete floor slabs due to its advanced features. The elimination of compaction enables the casting of large area of concrete slab to be completed in shorter time with reduced cost and manpower required. Besides, when fibers reinforced with SCC will improve the tensile properties, flexural strength, impact strength, toughness, and post- cracking behaviour of concrete. Therefore, SCC is an ideal solution for the construction of concrete slabs to maintain the serviceability of slab throughout their service lifespan. Figure show the casting of a large area of concrete slab with congested reinforcement in commercial centre in Italy.

- Objective
- The objective of present work is to identify the three key properties of self-compaction concrete i.e. filling ability, passing ability and segregation resistance.
- To find the workability aspects of M20 grade concrete.
- To decrease the permeability and to reduce the shrinkage in self-compacting concrete and finding out the right workability for construction work.
- To find the best suitable dosage of Nano-Silica for SCC.

- Scope

The scope of this project is to add Nano-Silica powder dosage required from compatibility studies based on the test. Design of SCC mix for selected range of control parameters, so as to achieve the target performance characteristics. Study the properties of the Nano-Silica. Study of fresh and hardened properties of concrete.

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

III. METHODOLOGY AND EXPERIMENTATION

- Laboratory Setup

The concrete lab available at St. Martin‟s Engineering College is used for the project. The workability test equipments are used for filling ability and passing ability.

- Procurement of Materials

The Materials used for the study are:
i) Cement
ii) Fine Aggregate
iii) Coarse Aggregate
iv) Water
v) Admixture

i) Cement
In the present investigation jaypee, Ordinary Portland Cement (OPC) of 53 Grade confirming to IS: 12269:1999 was used. The physical properties of cement as per IS: 12269:1999 when tested at the concrete lab at St. Martin‟s Engineering College are shown below.

Cement starts to set when mixed with water which causes a series of hydration chemical reactions. The constituents slowly hydrate and the mineral hydrates solidify the interlocking of the hydrates gives cement its strength.

Contrary to popular perceptions, hydraulic cements do not set by drying out, proper curing requires maintaining the appropriate moisture content during the curing process. If hydraulic cements dry out during curing, the resulting product can be significantly weakened.

Portland cement is by far the most common type of cement in general use around the world. This cement is made by heating limestone (calcium carbonate) with other materials (such as clay) to 1450 °C in a kiln, in a process known as calcination, whereby a molecule of carbon dioxide is liberated from the calcium carbonate to form calcium oxide, or quicklime, which then chemically combines with the other materials that have been included in the mix to form calcium silicates and other cementitious compounds.

The resulting hard substance, called 'clinker', is then ground with a small amount of gypsum into a powder to make 'ordinary Portland cement', the most commonly used type of cement (often referred to as OPC). Portland cement is a basic ingredient of concrete, mortar and most non-specialty grout. The most common use for Portland cement is in the production of concrete. Concrete is a composite material consisting of aggregate (gravel and sand), cement and water.

As a construction material, concrete can be cast in almost any shape desired, and once hardened, can become a structural (load bearing) element. Portland cement may be grey or white

ii) Fine 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

Locally available river sand confirming to IS: 383:1970 was used as the fine aggregate in the concrete preparation.

Table: 1 Properties of Fine Aggregates

Construction aggregate, is a broad category of coarse particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geosynthetic aggregates. Aggregates are the most mined materials in the world. Aggregates are a component of composite materials such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material. Due to the relatively high hydraulic conductivity value as compared to most soils, aggregates are widely used in drainage applications such as foundation and French drains, septic drain fields, retaining wall drains, and road side edge drains. Aggregates are also used as base material under foundations, roads, and railroads. In other words, aggregates are used as a stable foundation or road/rail base with predictable, uniform properties or as a low-cost extender that binds with more expensive cement or asphalt to form concrete.

Fine aggregate is natural sand which has been washed and sieved to remove particles larger than 5 mm and coarse aggregate is gravel which has been crushed, washed and sieved so that the particles vary from 5 up to 20 mm in size. The fine and coarse aggregate are delivered separately. Because they have to be sieved, a prepared mixture of fine and coarse aggregate is more expensive than natural all-in aggregate.

The reason for using a mixture of fine and coarse aggregate is that by combining them in the correct proportions, a concrete with very few voids or spaces in it can be made and this reduces the quantity of comparatively expensive cement required to produce a strong concrete**.**

Sieving can be done by holding the sieving in both hands and gentle wrist motion; this will be involving the no danger of spilling of sand. This shall be kept well spread out on the screen. More or less continuous rotation of sieve can be carried out throughout the sieving. Washers, shorts and slugs shall not be used on the sieve. The underside of sieve shall be lightly brushed with a85-100mm of brittle brush after even five minutes of sieving. Mechanically sieving devices may be used but the sand cannot be rejected if it meets fineness requirement.

iii) Coarse Aggregate

Coarse aggregate of nominal size 20 mm and 12 mm, obtained from the local quarry confirming to IS: 10262:2009 was used. The properties of coarse aggregate are shown in Table 3.3.3. The coarse aggregate used for the preparation of concrete is a mixture of 20 mm and 12 mm size aggregates in ratio 1:2

Table 2 Properties of Coarse Aggregate

The advent of modern blasting methods enabled the development of quarries, which are now used throughout the world, wherever competent bedrock deposits of aggregate quality exist. In many places, good limestone, granite, marble or other quality stone bedrock deposits do not exist.

In these areas, natural sand and gravel are mined for use as aggregate. Where neither stone, nor sand and gravel, are available, construction demand is usually satisfied by shipping in aggregate by rail, barge or truck. Additionally, demand for aggregates can be partially satisfied through the use of slag and recycled concrete. However, the available tonnages and lesser quality of these materials prevent them from being a viable replacement for mined aggregates on a large scale. Large stone quarry and sand and gravel operations exist near virtually all population centers. These are capital-intensive operations, utilizing large earth-moving equipment, belt conveyors, and machines specifically designed for crushing and separating various sizes of aggregate, to create distinct product stockpiles. Aggregates themselves can be recycled as aggregates. Unlike deposits of sand and gravel or stone suitable for crushing into aggregate, which can be anywhere and may require overburden removal and/or blasting, "deposits" of recyclable aggregate tend to be concentrated near urban areas, and production from them cannot be raised or lowered to meet demand for aggregates. Supply of recycled aggregate depends on physical decay of structures and their demolition. The recycling plant works best for asphalt-aggregate recycling. The material being recycled is usually highly variable in quality and properties. Many aggregate products of various types are often recycled for other industrial purposes.

S.No	Weight of cement (gms)	Weight of residue Formed (gms)	Fineness of cement (%)
1	300	20	6.67
2	300	30	10
3	300	30	10

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iv) Water

Water used for mixing the concrete ingredients, casting and curing the test specimens is free from impurities which when present can adversely influence the strength of concrete confirming to IS:3025:1964 (part 22 and 23) and IS:456:2000.

v) Admixture

Admixture plays a vital role which makes SCC possible. The admixture used in this experiment is conplast SP430 (a polycarboxylate based superplasticizer).Without doubt the invention of polycarboxylate-based superplasticizers is one of the most important admixture discoveries in recent years. They offered enormous advantages when compared to existing products. Fortunately, during the time they've been marketed they have undergone continuous refinement because they are based on engineered molecules. The refinements include extending working time and more consistent results wherever they are used. They are the admixtures that makes SCC possible. One of the main tasks when producing SCC is to have an outstanding fluid concrete and keep its water content low at the same time. The very good workability must not allow disintegration or separation of freshconcrete. We also have significantly increased fines content in the mix that increases the specific surface that has to be lubricated.

These facts require special concrete admixtures that

- Give an extremely strong plasticizing effect
- Allow very high water reduction
- Help to keep the concrete stable and homogeneous

- Tests on Cement

i) Fineness of Cement

Weigh approximately 300g of cement to the nearest 0.01g and place it on the sieve. Agitate the sieve by swirling, planetary and linear movements, until no more fine material passes through it. Weigh theresidue and express its mass as a percentage w1, of the quantity first placed on the sieve to the nearest 0.3 percent. Gently brush all the fine material off the base of the sieve. Repeat the whole procedure using a fresh 300g sample to obtain w2. Then calculate R as the mean of w1 and w2 as a percentage, expressed to the nearest 0.1 percent. When the results differ by more than 1 percent absolute, carry out a third sieving and calculate the mean of the three values.

ii) Observation and Calculations:

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

Table 3 Fineness of Cement

Fineness of Cement= (10+6.67+10)/3 = 8.89%

The finesse of cement is 8.89%, which is less than 10%.

- Soundness Test on Cement

Before Performing the test, calculate the standard consistency of cement to find out the water required to obtain the normal consistency(P).Now add 0.78 times of water to the cement to give a paste of standard consistency (0.78P).Lightly apply oil to the Lechateliermould and place it on a glass plate.Now pour the cement paste into mould and close the mould using lightly oiled glass plate and to avoid misplacement place a weight on it.Then submerge the whole assembly for 24Hrs in water bath at a temperature of 27C .Remove the entire apparatus from water and then calculate the distance separating two indicator points using measuring scale and note it as L1.Again submerge the whole assembly in a water bath at a temperature of boiling point for 3hours.After completion of 3hours remove the assembly from the bath and measure the distance between two indicator points and note it as L2.

- Calculations

Soundness/expansion of cement = L1-L2

L1=Measurement taken after 24 hours of immersion in water at a temp. of 27 ±20 C =12 mm

L2=Measurement taken after 3 hours of immersion in water at boiling temperature =15 mm

Cement	% of water added	Time (sec)	Penetration (mm)
250gms	0.85x31% of weight of Cement 0.85/100x(31)x(250) =66.93575	5	0
		10	0
		15	0
		20	0
		25	3
		30	5
		35	6
		40	10

Soundness of Cement = 3 mm

- Normal Consistency of Cement sample

Take 250gm of cement and weight carefully and add 20% water in it. Care should be taken that mixing time is not less than 3min and gauging shall be counted from the time of adding water. Fill the paste in the mould .The excess paste to trim off and vibration are given to remove air bubbles. Fix the 10mm dia. plunger in the moving rod and bring down in touch with the paste. Release the plunger. Repeat the procedure till it penetrate 33-34mm from the top & note down the water percentage.

- Observations and Calculations:

Table 4 Normal Consistency

The percentage of water for normal consistency for the given sample of Cement is 31.67%.

- Determination of Initial and Final Setting Time

Take about 500gms of cement. Add water of standard consistency. To make cement paste. To make the surface of the cement paste is till smooth and Level. The whole assembly kept in vicat’s apparatus.

Bring the needle in the rod gently near the surface of the test block and release it quickly allowing it to penetrate into the block and note the time. Repeat the procedure till the needle fails to penetrate into the test block by 5mm to 7mm from the bottom of the mould. Generally the initial setting time of cement is not less than 30min.

- Observation:
- Quantity of cement = 250 gms.
- Water for standard Consistency = 31.67%

- Observation Table:

Table 5 Initial and Final Setting Time

- 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

S.No	% of water added	Penetration
	27X(250/100)	33
	28X(250/100)	25
250gms	29X(250/100)	15

30X(250/100)	10
31X(250/100)	7

The properties of fine aggregate are shown in Tables below.

Weight of sand = 1000gms
Weight of pan = 814gms

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 microns	26.03	42.60	57.38
5	300 microns	32.50	75.10	24.90
6	150 microns	21.20	96.30	3.70

Weight of pan +sand = 1814gms

Table 6 Sieve Analysis Results

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

- Bulking of Fine Aggregate

Put sufficient quantity of sand loosely into a container until it is 2/3 rd. full. Level the top surface of the sand.

Push the steel rule vertically down through the sand at the middle to bottom and measure the height 'h'. Empty the container and to a clean metal tray without any loss of sand. Add 2% water by weight of sand and mix thoroughly with hand.

Put back the loose sand into container without tamping it. Repeat above the procedure by increasing the moisture content in the sample till the bulking is maximum starts dropping ultimately zero.

Prepare bulking chart by plotting increase volume verses percentage increase in moisture content.

- Calculation:

Initial reading h=17.9cm

S.no	% of water added to the weight of the sand	Height of moist sand in cm(hi)	Percentage of bulking of sand (hi-h)/h*100
1	2	20.5	12.02
2	4	22.5	22.9
3	6	23	25.6
4	8	22	22.02
5	10	21	14.75
6	12	19.7	7.65

Table 7 Bulking of Fine Aggregate

Bulking of fine aggregate is 25.6%.

- Self-Compacting Concrete

Self-Compacting Concrete is a composite material composed of coarse aggregate bonded together with a fluid cement that hardens over time. Most concretes used are lime-based concretes such as Portland cement concrete or concretes made with other hydraulic cements.

When aggregate is mixed together with dry Portland cement and water, the mixture forms a fluid slurry that is easily poured and molded into shape. The cement reacts chemically with the water and other ingredients to form a hard matrix that binds the materials together into a durable stone-like material that has many uses. Thorough mixing is essential for the production of uniform, high-quality concrete. For this reason equipment and methods should be capable of effectively mixing concrete materials containing the largest specified aggregate to produce uniform mixtures of the lowest slump practical for the work.

Separate paste mixing has shown that the mixing of cement and water into a paste before combining these materials with aggregates can increase the compressive strength of the resulting concrete. The paste is generally mixed in a high-speed, shear-type mixer at a w/cm (water to cement ratio) of 0.30 to 0.45 by mass. The cement paste premix may include admixtures such as accelerators or retarders, super plasticizers, pigments, or silica fume. The premixed paste is then blended with aggregates and any remaining batch water and final mixing is completed in conventional concrete mixing equipment.

Mixing concrete is simply defined as the "complete blending of the materials which are required for the production of a homogeneous concrete." Batching is the "process of weighing or volumetrically measuring and introducing into the mixer the ingredients for a batch of concrete" Initially we have weighed coarse aggregate, fine aggregate and cement according to the mix design and water according to the w/c ratio. Then we weighed the desired quantities of admixtures. First we added coarse aggregate in the concrete mixer followed by fine aggregate, cement and admixtures. Then start the mixer and allowed dry mixing until the materials are properly mixed and started adding water simultaneously. Mixed for getting a homogeneous mixture.

Self-compacting concrete has been used as a special concrete only in large general construction companies in Japan. In order for self-compacting concrete to be used as a standard concrete rather than a special one, new systems for its design, manufacturing and construction of self-compacting concrete need to be established. Various committee activities on self-compacting concrete have been carried out as a result. Among them, a system by which the ready-mixed concrete industry can produce self-compacting concrete as a normal concrete would seems the most effective in Japan, as much as 70% of all concrete is produced by the ready-mix concrete industry

- Workability Test

Slump Test

Slump Test is used to determine the consistency of concrete mix of given proportions. Scope and significance unsupported fresh concrete flows to the sides and a sinking in height takes place. This vertical settlement is known as slump. In this test fresh concrete is filled into a mould of specified shape and dimensions, and the settlement or slump is measured when supporting mould is removed. Slump increases as water-content is increased. For different works different slump values have been recommended. confirming to IS:1199-1959 was used

The slump is a measure indicating the consistency or workability of cement concrete. It gives an idea of water content needed for concrete to be used for different works.

A concrete is said to be workable if it can be easily mixed, placed, compacted and finished. A workable concrete should not show any segregation or bleeding. Segregation is said to occur when coarse aggregate tries to separate out from the finer material and a concentration of coarse aggregate at one place occurs.

Self-Compacting Concrete (SCC) is a modern concrete technology that allows significant advantages compared to conventional concrete. Extreme workability, self-compaction without vibration combined with high concrete quality allows new and interesting applications for the competitive users and creative specifiers of concrete. The advantages of SCC are important for the applicators (contractors) and concrete producers (Ready mixed concrete, Precast concrete) as well as for the final users of the structure. Knowledge about its properties, design and production is essential for the successful use of SCC. Creativity is also necessary, because the use of this technology is just starting to spread and new, interesting applications for SCC are found every day.

This results in large voids, less durability and strength. Bleeding of concrete is said to occur when excess water comes up at the surface of concrete. This causes small pores through the mass of concrete and is undesirable. By this test we can determine the water content to give specified slump value. In this test water content is varied and in each case slump value is measured till we arrive at water content giving the required slump value. This test is not a true guide to workability.

- Consistency Test

- Flow Table Test

Flow table test is performed to determine the consistency of the concrete mix. 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. Confirming to IS: 1199-1959 was used.

- L-Box

The test assesses the flow of the concrete and also the extent to which it is subjected to blocking by reinforcement. The apparatus consist of rectangular section box in the shape of an ‘L’, with a vertical and horizontal section, separated by a movable gate, in front of which vertical length of reinforcement bar are fitted. The vertical section is filled with concrete, and then the gate lifted to let the concrete flow into the horizontal section. When the flow has stopped, the height of the concrete at the end of the horizontal section is expressed as a proportion of that remaining in the vertical section. It indicates the slope of the concrete when at rest. This is an indication passing ability, or the degree to which the passage of concrete through the bars is restricted. The horizontal section of the box can be marked at 200mm and 400mm from the gate and the times taken to reach these points measured. Confirming to IS: 1199-1959 was used.

The section of bar con be of different diameters and are spaced at different intervals, in accordance with normal reinforcement considerations, 3x the maximum aggregate size might be appropriate. The bar can principally be set at any spacing to impose a more or less severe test of the passing ability of the concrete.

This is a widely used test, suitable for laboratory and perhaps site use. It asses filling and passing ability of SCC, and serious lack of stability (segregation) can be detected visually. Segregation may also be detected by subsequently sawing and inspecting sections of the concrete in the horizontal section. Unfortunately there is no arrangement on materials or dimensions or reinforcing bar arrangement, so it is difficult to compare test results.

- V-Funnel

The equipment consists of a v shaped funnel as, show in Fig. An alternative type of V-funnel, the O funnel, with circular. The test was developed in Japan and used by Ozawa et al. The equipment consists of V-shaped funnel section is also used in Japan. The described V-funnel test is used to determine the filling ability (flow ability) of the concrete with a maximum aggregate size of 20mm. The funnel is filled with about 12 liter of concrete and the time taken for it to flow through the apparatus measured. After this the funnel can be refilled concrete and left for 5 minutes to settle. If the concrete shows segregation then the flow time will increases significantly.confirming to IS: 1199-1959 was used.

Though the test is designed to measure flow ability, the result is affected by concrete properties other than flow. The inverted cone shape will cause any liability of the concrete to block to be reflected in the result-if, for example there is too much coarse aggregate. High flow time can also be associated with low deformability due to a high paste viscosity, and with high inter-particlefriction. While the apparatus is simple, the effect of the angle of the funnel and the wall effect on the flow of concrete is not clear.

About 12 liter of concrete is needed to perform the test, sampled normally. Set the V-funnel on firm ground. Moisten the inside surface of the funnel. Keep the trap door to allow any surplus water to drain. Close the trap door and place a bucket underneath. Fill the apparatus completely with the concrete without compacting or tamping; simply strike off the concrete level with the top with the trowel.

Open within 10 sec after filling the trap door and allow the concrete to flow out under gravity. Start the stop watch when the trap door is opened, and record the time for the complete discharge (the flow time). This is taken to be when light is seen from above through the funnel. The whole test has to be performed within 5 minutes.

Do not clean or moisten the inside surface of the funnel gain. Close the trap door and refill the V-funnel immediately after measuring the flow time.

Place a bucket underneath. Fill the apparatus completely with concrete without compacting or tapping, simply strike off the concrete level with the top with the trowel. Open the trap door 5 minutes after the second fill of the funnel and allow the concrete to flow out under gravity.

Simultaneously start the stop watch when the trap door is opened and record the time discharge to complete flow (the flow time at T5 minutes). This is to be taken when light is seen from above through the funnel.

- U-Box

The test was developed by the Technology Research Centre of the Taisei Corporation in Japan. Sometime the apparatus is called a “box shaped” test. The test is used to measure the filing ability of self-compacting concrete. The apparatus consists of a vessel that is divided by a middle wall into two compartments; an opening with a sliding gate is fitted between the two sections. Reinforcing bar with nominal diameter of 134 mm are installed at the gate with centre to centre spacing of 50 mm. this create a clear spacing of 35mm between bars. The left hand section is filled with about 20 liter of concrete then the gate is lifted and the concrete flows upwards into the other section. The height of the concrete in both sections is measured. Confirming to IS: 1199-1959 was used.

This is a simple test to conduct, but the equipment may be difficult to construct. It provides a good direct assessment of filling ability-this is literally what the concrete has to do-modified by an unmeasured requirement for passing ability. The 35 mm gap between the sections of reinforcement may be considered too close. The question remains open of what filling height less than 30cm is still acceptable. About 20 liter of concrete is needed to perform the test, sampled normally. Set the apparatus level on firm ground, ensure that the sliding gate can open freely and then close it. Moisten the inside surface of the apparatus, remove any surplus water, fill the vertical section of the apparatus with the concrete sample.

Leave it stand for 1 minute. Lift the sliding gate and allow the concrete to flow out into the other compartment. After the concrete has come to rest, measure the height of the concrete in the compartment that has been filled, in two places and calculate the mean (H1). Measure also the height in the other equipment (H2). Calculate H1-H2, the filling height. The whole test has to be performed within 5 minutes.

- Mixing

Mixing is done according to the mix design of M20 grade. Calculated amount of cement, fine aggregate, coarse aggregate are first mixed in a tray with a trowel. Then 0.5% amount of admixture (naptha pc) by weight of cement is added to the prescribed water content. This mixture is added to the cement mixture in 2 to 3 trials. Mixing is done to achieve uniform mixture.

Self-Consolidating Concrete (SCC) is, in the fresh state, more sensitive to small variations in the constituent elements and the mixing procedure compared to Conventional Vibrated Concrete. Several studies have been performed recently to identify robustness of SCC and to develop solutions to increase the robustness of SCC. Ghent University obtained a major research project from the Research Foundation in Flanders (FWO) to investigate fundamentally robustness of SCC and to identify potential solutions in the form of alternative materials to enhance robustness. In the present research project, Missouri University of Science and Technology (Missouri S&T) extended the research at Ghent University by investigating the influence of the mixing procedure on the robustness of SCC. The project was split into four tasks. In a first task, the sequence of adding the constituent elements and mixing was investigated by measuring the rheological properties of cement pastes.

In a second task, the combined influence of the most significant mix design and mixing procedure parameters were investigated, with particular attention to the mix design parameters which influence the robustness of the cement paste to a change in time of addition of the superplasticizer.

In the third task, the results obtained on cement pastes were validated on concrete scale, with focus on the adding sequence of the aggregates and their initial moisture content. In the fourth task, the robustness of thixotrophy and loss of workability was investigated on cement paste and concrete scale. To enhance the application of SCC for the construction and repair of transportation infrastructure, two key concepts are of importance: quality control and consistency. The consistency refers to the mixing operations and transportation of SCC. It is recommended to keep the mixing procedure constant for every SCC produced. This includes the addition sequence of the materials, the mixing time, the mixing speed and the concrete volume (parameter not tested, but it is reflected in mixing energy). The quality control is not only necessary to determine the moisture content of the aggregates, but also for any of the other constituent elements used

IV. EXPERIMENTAL PROGRAM

In this work an attempt is made to study the various properties of self-compacting concrete. Also the strength characteristics of self-compacting concrete like compressive strength is found.

- The following steps are included in this phase

1 Design of concrete mix
2 Mixing of concrete
3 Test Specimens
4 Preparation of Moulds
5 Harden Properties of Self Compacting Concrete
6 Observations and Test Results

- Mixing of concrete

The coarse and fine aggregates with sufficient water to wet the aggregate and mixed for 30 seconds in a pan-type mixer. The cement is added with 70% of the mixing water and mixed for further 2 minutes. Finally the remaining water mixed with super plasticiser was added and the mixing was continued for one minute. Then the mixing was halted for 2 minutes and the mixing was continued for another two minutes.

- Test Specimens

Three types of element have been used in these investigation namely the cubes and beams and cylinder. The cubes used are of size 150*150*150mm, beams of size 100*100*500mm and cylinder of 150Φ*300mm

- Preparation of Moulds

Mould of cubes, beams and cylinder has been cleaned and oiled for facilitate easy demoulding. After conducting the flow characteristics experiments the concrete mix was poured in the moulds required for strength assessment. After pouring the concrete into the moulds no compaction was given either through vibration or through hand compaction. Even the concrete did not require any finishing operation. After 24 hours of casting the specimens were demoulded and were transferred to the curing tank. After the curing period of 7,14 and 28 days specimen removed from curing tank and screed off the all face of specimen and taken for testing.

- Strength test

The compressive strengths of the casted specimens were determined by the compressive test machine and are tabulated as follows:

- Compressive Strength Test:

A test result is the average of at least three standard-cured strength specimens made from the same concrete sample and tested at the same age. In most cases strength requirements for concrete are at an age of 28 days of curing. The concrete cubes, after 28 days were tested for their compressive strength in the following manner. After cleaning of bearing surface of compression testing machine, the axis of the specimen was carefully aligned with the center of thrust of the plate. No packing was used between faces of the test specimen and platen of testing machine. The load was applied without shock and increased continuously at rate of approximately 140 Kg/cm2/min until the resistance of the specimen to the increasing load broke down and no greater load could be sustained. The compressive stress calculated in Kg/cm2 from the maximum load sustained by the cube before failure.

V. RESULTS AND ANALYSIS

- Workability Test
- Slump Test

The influence of different combinations of super plasticizer with normal concrete at a constant w/c ratio of 0.43 has shown a trend of decrease in workability (slump). The observed values are tabulated below.

Table 4.1.1 Slump Cone Results

S.No.	Desription	Slump Value
1	NOMINAL CONCRETE	270mm
2	SCC	650mm
3	SCC 2.5%	55mm
4	SCC 3%	62mm
5	SCC 3.5%	59mm

- Consistency Test

- Flow Table

The flow table is then lifted up 40mm and then dropped 15 times, causing the concrete to flow. After this the diameter of flow of the concrete is measured. The measured diameter of flow of concrete are as follows:

Table.8 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

- L-Box

The L-Box should be filled by the concrete upto its 1/3rd .The concrete flows through the L-Box by its self-weight. The time taken by the concrete to reach the end of L-Box is tabulated below.

Table 9 L-Box

S.No.	Description	Filling Height (mm)		
		H1	H2	H2/h1
1	SCC	58	58	1.0
2	SCC 2.5%	65	51.25	0.78
3	SCC 3%	77	73.15	0.92
4	SCC 3.5%	75	70	0.93

- V-Funnel

This test measures the ease of flow of concrete, shorter flow time indicates greater flow ability. For SCC a flow time of 10 seconds is considered appropriate.

The inverted cone shape restricts the flow, and prolonged flow times may give some indication of the susceptibility of the mix to blocking. After 5 minutes of settling, segregation of concrete will show a less continuous flow with an increase in flow time.

Table 9-V Funnel

S.No	Description	Flow Time(sec)
1	SCC	12
2	SCC 2.5%	11.7
3	SCC 3	10.1
4	SCC 3.5%	9.8

- U-Box

If the concrete flows as freely as water, at rest it will be horizontal, so H1-H2=0. Therefore the nearest this test value, the 'filling height', is to zero, the better the flow and passing ability of the concrete.

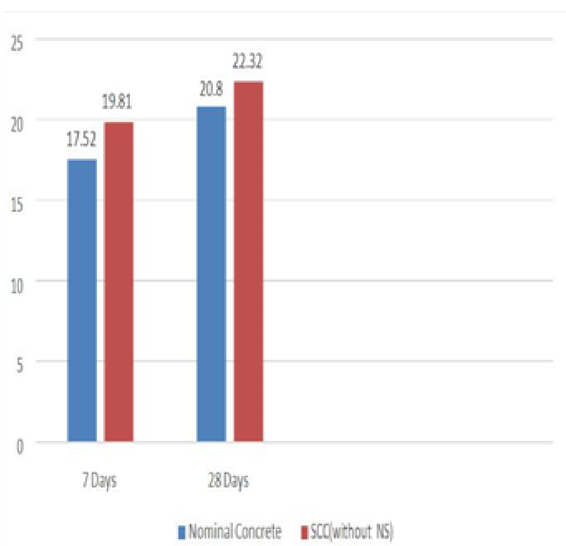
Table 10 U-Box

S.No	Description	Filling Height(cms)
1	SCC	30
2	SCC 2.5%	26
3	SCC 3%	26
4	SCC 3.5%	24

Compressive Strength Values

S.No	Mix Designation	Characteristic Compressive Strength(N/mm^2)	
		7 days	28 days
1	Nominal Concrete	17.52	20.8
2	SCC	19.81	22.32

Graphs are plotted for the obtained results and increase in the characteristic compressive strengths can be clearly read out. It was observed that the percentage increase in compressive strength was greater for 7 days compared to 28 days. Hence from the experimental investigation results it can be inferred that Nano-silica improves early strength also.



Compressive Strength of Nominal concrete and SCC (without NS)

- Nano silica

Word Nano silica is divided into two words, Nano means particle of maters that is between 1 and 100 nanometres (nm) in diameter and Silica also known as silicon dioxide.

Nanoparticles are usually distinguished from "fine particles", sized between 100 and 2500 nm, and "coarse particles", ranging from 2500 to 10,000 nm. They are a subclass of the colloidal particles, which are usually understood to range from 1 to 1000 nm. Metal particles smaller than 1 nm are usually called atom clusters instead.

Being much smaller than the wavelengths of visible light (400-700 nm), nanoparticles cannot be seen with ordinary optical microscopes, requiring the use of electron microscopes. For the same reason, dispersions of nanoparticles in transparent media can be transparent.

International Union of Pure and Applied defined a nanoparticle as "a particle of any shape with dimensions in the 1×10^{-9} and 1×10^{-7} m range". This definition evolved from one given by IUPAC in 1997. According to the International Standards Organization (ISO) technical specification 80004, a nanoparticle is an object with all three external dimensions in the nanoscale, whose longest and shortest axes do not differ significantly, with a significant difference typically being a factor of at least 3. The properties of a material in nanoparticle form are usually very different from those of the bulk material even when divided into micrometer-size particles. A number of causes contribute to that effect. Like large area/volume ratio , when A bulk material should have constant physical properties (such as thermal and electrical conductivity, stiffness, density and viscosity) regardless of its size. However, in a nanoparticle, the volume of the surface layer (the material that is within a few atomic diameters of the surface) becomes a significant fraction of the particle's volume; whereas that fraction is insignificant for particles with diameter of one micrometer or more.

Silica dioxide is most commonly found in nature as quartz and in various living organisms. In many parts of the world, silica is the major constituent of sand. Silica is one of the most complex and most abundant families of materials, existing as a compound of several minerals and as synthetic product. Notable examples include fused quartz, fumed silica, silica gel and aerogels. It is used in structural materials, microelectronics (as an electrical insulator), and as components in the food and pharmaceutical industries. Silica with the chemical formula SiO_2, which comprises more than 10% by mass of the earth's crust. Silica is the only polymorph of silica stable at the Earth's surface. Metastable occurrences of the high-pressure forms coesite and stishovite have been found around impact structures and associated with eclogites formed during ultra-high-pressure metamorphism. The high-temperature forms of tridymite and cristobalite are known from silica-rich volcanic rocks. In many parts of the world, silica is the major constituent of sand. The various forms of silicon dioxide can be converted from one form to another by heating and changes in pressure. Even though it is poorly soluble, silica occurs in many plants. Plant materials with high silica phytolith content appear to be of importance to grazing animals, from chewing insects to ungulates. Silica accelerates tooth wear, and high levels of silica in plants frequently eaten by herbivores may have developed as a defense mechanism against predation.

Silica is also the primary component of rice husk ash, which is used, for example, in filtration and cement manufacturing.For well over a billion years, silicification in and by cells has been common in the biological world. In the modern world it occurs in bacteria, single-celled organisms, plants, and animals (invertebrates and vertebrates). About 95% of the commercial use of silicon dioxide (sand) occurs in the construction industry, e.g. for the production of Portland cement concrete.Silica, in the form of sand is used as the main ingredient in sand casting for the manufacture of metallic components in engineering and other applications. The high melting point of silica enables it to be used in such applications.

- Production of Nano Silica

Silicon dioxide is mostly obtained by mining, including sand mining and purification of quartz .Quartz is suitable for many purposes, while chemical processing is required to make a purer or otherwise more suitable (e.g. more reactive or fine-grained) product.

Silica fume is obtained as by product from hot processes like ferrosilicon production. It is less pure than fumed silica and should not be confused with that product. The production process, particle characteristics, and fields of application of fumed silica differ from those of silica fume.

VI. SCANNING ELECTRO MICROSCOPY

A scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by scanning the surface with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that contain information about the surface topography and composition of the sample. The electron beam is scanned in a raster scan pattern, and the position of the beam is combined with the intensity of the detected signal to produce an image. In the most common SEM mode, secondary electron emitted by atoms excited by the electron beam are detected using a secondary electron detector. The number of secondary electrons that can be detected, and thus the signal intensity, depends, among other things, on specimen topography. SEM can achieve resolution better than 1 nanometer.

Specimens are observed in high vacuum in conventional SEM, or in low vacuum or wet conditions in variable pressure or environmental SEM, and at a wide range of cryogenic or elevated temperatures with specialized instruments

We went to SEM LAB in OUCT (Osmania University College of Technology) at Osmania University, Hyderabad, and Telangana. 3 samples of specimen war tested. This samples contain of cement, nano silica and cement + nano silica.

Where cement+ nano silica is made up by taking 300 grams of cement and 50 grams (0.3%) of nanao silioca and 0.55 water cement ratio. The sample is placed for 24 hours and allowed for harden the sample. After 24 hours sample is crushed and 10gm of powder is cared on to test.

SAMPLE 1: CEMENT

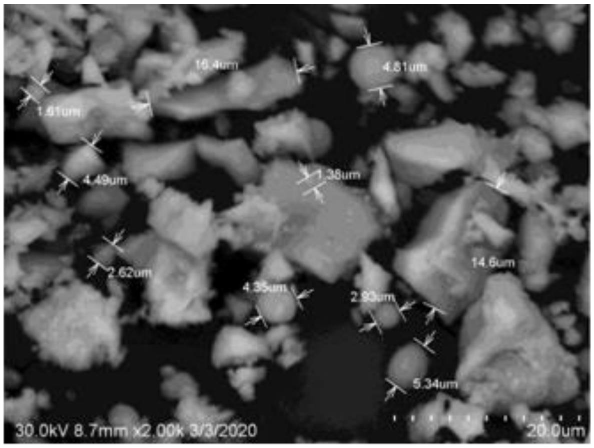


Figure 1: Cement

PixelSize=49.60938 AcceleratingVoltage=30000 Volt Magnification=2000 WorkingDistance=8700 um EmissionCurrent=112000 nA Vacuum=60
MicronMarker=20000
ColorMode=Grayscale
Condition=Vacc=30kV Mag=x2.00k WD=8.7mm

Particles size in cement are in a range from 1.38 to 16.4 um And particles are in circular and irregular in shapes. Cement particales cantain void spaces in in between them.

Sample 2: NANO SILICA POWDER

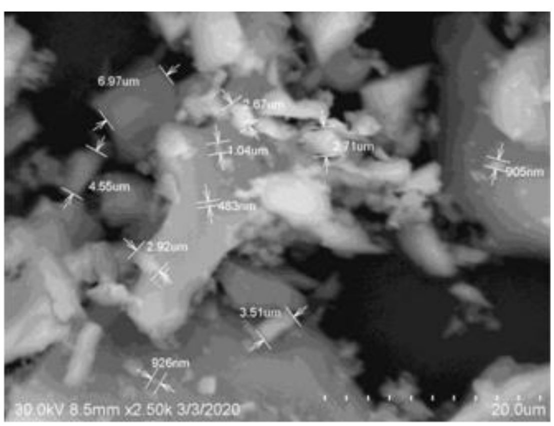


Figure 2: Nano Silica Powder

PixelSize=39.6875
AcceleratingVoltage=30000 Volt
Magnification=2500
WorkingDistance=8500 um

EmissionCurrent=108000 nA
Vacuum=60
ColorMode=Grayscale
Condition=Vacc=30kV Mag=x2.50k WD=8.5mm

Particles size in nano silica powder are in a range from 0.915to 1.45um and particles are in a shapes of irregular. Size of nano particles is less compare to cement particales.

SAMPLE 3: CEMENT +NANO SILICA

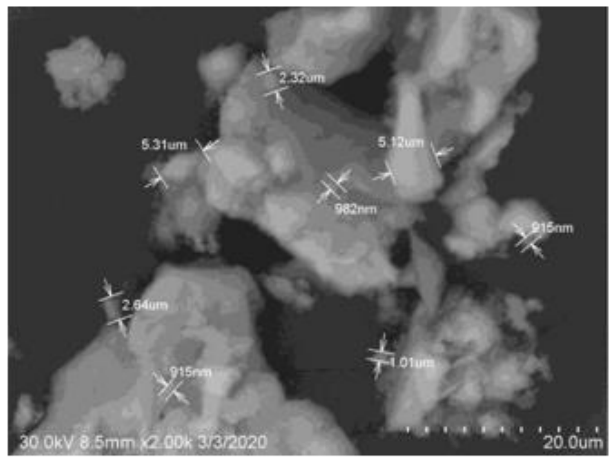


Figure 3:Nano Silica Powder+Cement

PixelSize=49.60938
AcceleratingVoltage=30000 Volt
Magnification=2000
WorkingDistance=8500 um

Vacuum=60
ColorMode=Grayscale
Condition=Vacc=30kV Mag=x2.00k WD=8.5mm

Fig 3 shows us the bounding between cement and nano particals. Where the nano particles of size 915um placed in between the cement particales of size range between 2.32um to 5.12um. When compare to cement particals nano silica particals size is less and it may help to fill the void space in cement. Do to less void space dencity of product is increased and it may help in increase in strength. As we know that cement cantain 22% of silica contain by adding nano silica the strength of the particle will increase.

CONCLUSION

The reason of this project is to design a suitable SCC mix by addition of Nano-Silica. For dating the suitable SCC mix we evaluate it by 4 tests which are slump flow, V-Funnel, L-Box and then determine the strength of it by casting the concrete in cubes and then put it in the compression machine and measure the strength after 7-days curing. If Nano-Silica we made Scanning Electro Microscopy Test. We also compared the compressive strength of Nominal Concrete and SCC without Nano-Silica.

The main conclusions of this project are:

- SCC is recommended in complicated frameworks which have narrow places and congested steel bars, because it can flow throw this places very smoothly and without vibration and give the best compaction and surface finishes.

- 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.

- Compressive strength of SCC (without NS) shows a increase of 2% in the test results of when compared to Nominal Concrete both in 7 days and 28 days.

- Fourteen trails have been done for SCC and the critical ingredients were the superplasticizer, VMA and fine materials (cement & fly ash) which play a big role in the SCC properties.

- 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.

- When compared with normal concrete self-compaction concrete shows a significant increase due to well compacted as density increases in concrete strength also increases.

- By decreasing the water percentage we are adding superplasti.

- 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.

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