Experimental Study on Workability of Self-Compaction Concrete

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***Abstract*:- A self-compaction concrete (SCC) is a special concrete developed to easily flow and pass through reinforcement and fill the formwork without any external force. And saves time, energy and cost of construction.In this study we have conducted test on workability of SCC and various components of concrete matrix such as cement, coarse aggregate, fine aggregate, water and chemical admixtures and found appropriate results of our project. SCC is more efficient in flow ability and fills the formwork without any external forces and provides flexibility to design and cast a structure with different shapes.This project study contributes to the comparing and understanding of properties of nominal a self-compaction concrete with various mix proportions.We have conducted various workability tests like Flow table test, slump cone test, J-ring test, L-Box test, U-Box test, V-funnel test in our laboratory to determine the difference between the nominal and c self-compaction concrete.We have also conducted SEM analysis on cement and Nano silica particles used in the project.**

***Keywords* — Self-constricting, Matrix, Mix proportion, SEM analysis, Compaction.**

I. INTRODUCTION

Self-compacting concrete (SCC) is an advanced concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as old-style vibrated concrete. The segregation of vibrating equipment improves the environment on and near construction and precast sites where concrete is being placed, reducing the exposure of workers to noise and vibration. SCC is still not widely used in India in spite of its several advantages including discount in labor and fast track construction etc. This is because of lack of sufficient data and evidence on SCC made of materials available in the different parts of the country and hence insufficient certainty of engineers in producing this material. India devours overflowing supply of fly ash, with its sources well distributed across the country. SCC generally holds a high powder content which keeps the concrete cohesive with high flow ability. This high powder satisfied is required to maintain a sufficient yield value of the fresh mix and cement cannot be the only powder material in SCC. For achieving economy, a extensive part of this powder could also contain fly ash. SCC can quarter more than 200 kg/m3 of fly ash which is observed as a high-volume addition. Hence it is careful worthwhile to examine the influence of fly ash in SCC.

Concrete usually has unique and complicated microstructure which makes it hard to observe and explore the presence of mineral. Replacement of concrete ingredients alters the concrete microstructure and mechanical properties of concrete. However, there may be some imperfection and failure due to replacement of major concrete ingredients. Analysis of microstructure of concrete is the modern approach to examine the mineral composition in the concrete. X- ray Diffraction Analysis, Scanning Electron Microscope and Energy Dispersive Spectroscopy analysis are some of the contemporary techniques used for phase identification, micrograph and chemical characterisation of the unknown elements in the hydrated cement paste of concrete. The outcome from the micro structural study of concrete would give a clear idea about the development and distribution of hydration products in the hydrated cement paste obtained from the concrete sample. In this research paper, the sustainability of concrete was studied and analysed through Scanning Electron Microscope. The comparison between the compressive strength of the mixes were analysed and correlated with the microstructure of the concrete mixes. The microstructure of the concrete mixes were analysed using Scanning Electron Microscope (SEM) which practically helps to visualize the microstructure of the hydrated cement paste. The objective of this study is to experimentally analyse and study the strength and microstructural behaviorof sustainable High-performance concrete by replacing the concrete elements with alternative cost-effectiveby-products.

II. "MATERIALS USED"

Cement

Cement is such a material that has cohesive and paste properties in the presence of water such cement is called hydraulic cement. These involve introductory of silicates and aluminates of lime obtained from limestone and clay. In this experiment 53 grade ordinary Portland cement (OPC) with brand name Jaypee cement was used for all SCC mixes. The cement used was replacement and without any bumps, the testing of cement was done as per IS: 8112-1989.

Fine Aggregates

The sand used in this present study is collected from the bed of river Tungabhadra the sand passing through 4.75 mm size sieve is used in the preparation of concrete mix. The sand confirms to grading Zone II as per IS: 383- 1970 (Reiterated 1997). The properties of sand such as fineness modulus and specific gravity remained resolute as per IS: 2386-1963. The specific gravity of fine aggregate is originate to be 2.64 and consuming fineness modulus 2.62. The water absorption is 1.5%. The bulk density of fine aggregate in compact state 1768 kg/m^3.

Properties of Fine Aggregate

Properties	Fine Aggregate
Bulk Density	1670 kg/m^3
Specific Gravity	2.74
Water Absorption	1.29
Fineness modulus	2.42

Coarse Aggregate

The coarse aggregate used in this present education is 12mm (40%) & 16mm (60%) down size graded confirm to IS 383-1970 (Reaffirmed 1997) locally available crushed stone gained from local quarries. The physical properties have been determined. The specific gravity of coarse aggregate is found to be 2.65. The water absorption is 0.3%. The bulk density of coarse aggregate in compact state is 1584kg/m3.

Physical Properties of Coarse Aggregate

Properties	Coarse aggregate
Specific Gravity	2.649
Bulk Density	1670
Water Absorption	0.78%
Impact Value	24.3 %
Fineness modulus	6.5

Water

The water used in the mixing of concrete was potable water and its free from organic content, turbidity and salts confirms to IS 456-2000 was used for mixing and for curing throughout the experiment program.

Super plasticizer

As the locally available PCE based super plasticizers proved to be very effective in SCC; this study is carried out using such type of super plasticizers. CONPLAST SP430 Commercially available poly- carboxylic ether based super plasticizer it is an admixture of a new generation based on modified polycarboxylic ether. Conplast SP430 is a super plasticizer manufactured by Dom Constructive Solutions, was used in this experimentation. Its use enhances the workability of the mix and strength aspect, helps in producing a better compaction and finishing. It also permits reduction in water content.

Conplast SP430

High performance superplasticising admixture

Description

Conplast SP430 is a chloride free, superplasticising admixture based on selected sulphurated naphthalene polymers. It is supplied as a brown solution which instantaneously separates in water. Conplast SP430 disperses the fine particles in the concrete mix, permitting the water content of the concrete to perform more successfully. The very high levels of water lessening imaginable allow foremost increases in strength to be obtained.

Typical Dosage of Conplast SP430

The optimum dosage of Conplast SP430 to meet specific requirements should always be determined by trials using the materials and conditions that will be experienced in use. This allows the optimization of admixture dosage and mix design and provides a complete assessment of the concrete mix. Preliminary points for such trials, based on the primary use of the product, are to use a dosage within the normal typical ranges. For high strength, water reduced concrete the normal dosage range is from 0.70 to 2.00 liters/100 kg of cementitious material, including PFA, GGBFS and micro silica. For high workability concrete the normal dosage range is from 0.70 to 1.30 liters/100 kg of cementitious material. Where a combination of performance is required, such as some increase in workability combined with reduced water content, then the whole range of dosages from 0.70 to 2.00 liters/100 kg of cementitious quantifiable can be considered.

Mix Design Conplast SP430

Where the primary intention is to improve strengths, initial trials should be made with normal concrete mix designs. The addition of the admixture will allow the removal of water from the mix whilst maintaining the workability at the levels obtained before the use of the admixture. After initial trials, trivial modifications to the overall mix design may be made to optimise performance. Where the primary intention is to provide high workability concrete, the starting mix design should be one right for use as a pump mix. Advice on mix design for flowing concrete is existing from the Fosroc Customer Service Department. In correctly considered flowing concrete, the amended dispersion of the cement particles and the more competent use of mixing water will improve assortment cohesion. The 13 slight air entrainment obtained with Conplast SP430 will also help to minimise bleed and segregation. After early trials, minor adjustments to the mix design may be made to adjust performance.

Compatibility Conplast SP430

Conplast SP430 is compatible with other Fosroc admixtures used in the same concrete mix. All admixtures should be extra to the concrete discretely and must not be diverse together prior to addition. The significant proper- ties of concrete encompassing more than one admixture should be evaluated by the trial mix technique suggested on this data sheet to ensure that effects such by way of undesirable impedance do not occur. Conplast SP430 is suitable for use with all types of ordinary Portland cements and cement replacement resources such as PFA, GGBFS and silica fume.

Uses of Conplast SP430

- To provide excellent acceleration of strength gain at early ages and major increases in asset at all ages by knowingly tumbling water demand in a concrete mix.
- Predominantly suitable for precast concrete and other high primary strength necessities.
- To significantly expand the workability of site mixed and precast concrete without growing water demand.
- To provide improved durability by swelling ultimate strengths and plummeting concrete permeability
- In screeds it reduces the water content required to elasticity suitable workability for placing and compaction.

Advantages of Conplast SP430

- Major increases in strength at early ages without increased cement contents are of particular benefit in precast concrete, agreeing earlier disrobing times.
- Makes possible major reductions in water: cement ratio which allow the creation of high strength concrete without excessive cement fillings
- Use in making of flowing existing permits easier construction with quicker placing and compaction and summary labor costs without increasing water contented.
- Increased workability levels are maintained for longer than with ordinary sulphurated melamine admixtures.
- Improved interconnection and particle dispersion minimises segregation and bleeding and expands propel ability
- Chloride free, safe for use in prestressed and rein-forced existing.
- In screed material, the lower water contented leads to nearer drying times

Nano silica Gel(Cemsyn XTX)

BeeChems

Services since 1972

CemSyn ®

Nano silica Base Additives for Cementing Operations

Cemsyn is a series of silica-based binders /fillers used in the cementing and concreting operations to impart different properties to the resultant compositions. They have shown very good results for both vertical and horizontal cementing.

Different compositions and their uses can be highlighted as under:

- Very small particle Nano binders for providing excellent binding properties to the cement admixtures
- Nano binders for providing a coating on RCC exposed to corrosive and erosive environment like saline waters
- Large particle silica binders for cement admixtures for tunnels, dams to improve water resistance, eliminate water seepage and strengthen the RCC.
- To eliminate problems of seepage, erosion in constructions like Dams, Tunnels, Bridges etc.

Better packing of the csh leads to a high-density C.S.H which is practically a guarantee for slowing creep thus multiplying various times the lifespan of the concrete structure.

Nano fillers enter micro and nano pores and give denser concrete which has a high resistance to sulfate and chloride attacks, is less permeable and of course has a higher resistance to compaction

15%to40%Active Nano Content with particle size in the range of 5-40nm is generally used. For high temperature and saline atmospheres, formulations are prepared using low alkali silica binder.

Nano Silica particles when added to concrete make it easier to pump and present no segregation problems like micro silica. They also help in reducing the amount of binder in each concrete mix and give better results

Typical Product Specifications

Parameter	Range
Active Nano content (%wt/wt)	30.0-32.0
Ph(20Oc)	9.0-10.0
Specific gravity	1.20-1.22

III. MIXPROPORTION

In the present study, M20 grade of concrete was adopted and designed. Twocombinations of concrete mixes were prepared with the water-cement ratio of 0.5. The major concrete constituents was replaced with alternative by-products with certain Cement was replaced with NS (3% and 4%) The mix proportion designed for normal mix is given below.

Two mixes were prepared with different ranges of replacement of concrete ingredients. Cement was replaced with NS. mix proportions and its percentage of replacement of concrete ingredients are illustrated in the table below.

Mix proportioning

Mix proportion for SCC with Nano silica

Mix	Mixes (%)	Cement		Water	Coarse Aggregate	Fine Aggregate	Admixture (Conplast SP 430)
	NS	Cement	NS				
I.	3%	562.19	17.4	179.55	1135.6	608	3%
II.	4%	556.99	23.2		794.9		

IV. TESTAND RESULTS

4.1. Workability Test on SCC

4.1.1. Slump flow Test

Introduction

The slump flow is used to assess the horizontal free flow of SCC in the absence of obstructions. It was first developed in Japan (1) for use in valuation of underwater concrete. The test method is based on the test method for determining the slump. The diameter of the concrete circle is a measure for the filling ability of the concrete.

Assessment of test

This is a simple, rapid test procedure, though two people are needed if the T50 time is to be measured. It can be used on site, though the size of the base plate is somewhat awkward and level ground is essential. It is the most commonly used test, and gives a good assessment of filling ability. It gives no indication of the ability of the concrete to pass amongst reinforcement without spoiling, but may give some suggestion of resistance to segregation. It can be argued that the entirely free flow, unrestricted by any boundaries, is not representative of what materializes in practice in concrete construction, but the test can be commercially be used to assess the consistency of supply of ready-mixed concrete to a site from load to load.

Equipment

A mould in the shape of a truncated cone with the internal dimensions 200mm diameter at the base, 100 mm diameter at the top and a height of 300 mm, conforming to EN 12350-2base plate of a stiff none absorbing material, at least 700mm square, marked with a sphere marking the central location for the slump cone, and a further concentric circle of 500mm diameter

Equipment

- trowel
- scoop
- ruler
- stopwatch (optional)

Procedure for Slump flow test

About 6 liters of concrete is needed to perform the test, sampled normally. Moisten the base plate and inside of slump cone, Place base plate on level stable ground and the slump cone centrally on the base plate and hold down firmly. Fill the cone with the scoop. Do not tamp, simply strike off the concrete level with the top of the cone with the trowel. Remove any surplus concrete from around the base of the cone. Raise the cone vertically and allow the concrete to flow out freely. Simultaneously, start the stopwatch and record the time taken for the concrete to reach the 500mm spread circle. (This is the T50 time). Measure the final diameter of the concrete in two perpendicular directions. Calculate the average of the two measured diameters. (This is the slump flow in mm).

Properties and Acceptance Criteria for Slump Flow

Method	Properties evaluated by the test	Acceptance criteria		
		unit	min	max
Slump flow	Filling ability, flow ability, segregation and bleeding	mm	650	800

Observation and calculations

Slump flow Test Observations

Water cement ratio	Slump in cm
0.4	21cm
0.5	18cm
0.6	16cm

Result for Slump flow test

Slump value for the given SCC sample is found to be 21cm for W/C ratio of 0.4, 18cm for W/C ratio of 0.5 & 16cm for W/C ratio of 0.6

4.1.2.J Ring Test

Introduction

The principle of the J-Ring test may be Japanese, but no references are known. The J-Ring test itself has been developed at the University of Paisley. The test is used towards determine the passing ability of the concrete. The equipment consists of a rectangular section (30mm x 25mm) open steel ring, drilled vertically with holes to accept threaded sections of reinforcement bar. These sec+3tions of bar can be of diverse diameters and spaced at different intervals: in accordance with normal reinforcement considerations, 3x the maximum aggregate size might be appropriate. The diameter of the ring of vertical bars is 300mm, and the height 100 mm. The J-Ring can be used in coincidence with the Slump flow, the Orimet test, or eventually even the V- funnel. These combinations test the flowing ability and (the contribution of the J-Ring) the passing ability of the concrete. The Orimet time and/or slump flow spread are measured as usual towards assess flow Characteristics. The J-Ring bars can predominantly be set at any spacing to execute a more or less severe test of the passing ability of the concrete. After the test, the modification in height between the concrete inside and that just outside the J-Ring is measured. This is an indication of passing ability, or the degree to which the passage of existing through the bars is restricted.

Assessment of test

These mixtures of tests are considered to have great potential, though there is no general view on exactly how results should be construed. There are a number of options for instance it may be enlightening to associate the slump-flow/J-Ring spread with the unrestricted slump-flow: to what extent is it reduced? Like the slump-flow test, these blends have the weakness of being unconfined, and therefore do not replicate the way concrete is placed and moves in practice. The Orimet option has the benefit of being a dynamic test, also reflecting placement in preparation, though it suffers from demanding two operators.

Equipment

Mould, without foot pieces, in the shape of a truncated cone with the internal dimensions 200 mm diameter at the base, 100 mm diameter at the top and a height of300 mm. Base plate of a stiff non absorbing material, at least 700mm square, marked with a circle showing the central location for the slump cone, and a supplementary concentric circle of 500mm diameter

- Trowel
- Scoop
- Ruler

J-Ring a rectangular section (30mm x 25mm) open steel ring, drilled steeply withholds. In the holes can be screwed threaded sections of reinforcement bar (length100mm, diameter 10mm, and typography 48 +/- 2mm)

Procedure for J-ring test

About 6 liters of concrete is needed to perform the test, sampled normally. Moisten the base plate and inside of slump cone, Place base-plate on level stable ground. Place the J-Ring centrally on the base-plate and the slump-cone centrally inside it and hold down firmly. Fill the cone with the scoop. Do not tamp, simply strike off the concrete level with the top of the cone with the trowel. Remove any surplus concrete from around the base of the cone.

Raise the cone vertically and allow the concrete to flow out freely. Measure the final diameter of the concrete in two vertical directions. Calculate the average of the two measured diameters. (in mm). Mark the difference in height amongst the concrete just inside the bars and that just external the bars. Calculate the average of the difference in elevation at four positions (in mm). Note any edge of mortar or cement paste without coarse aggregate at the edge of the pool of concrete.

Properties and Acceptance criteria for J-ring

method	Properties evaluated by the test	Acceptance criteria		
		Unit	Min	Max
J-ring	Passing ability, flowing ability	mm	0	10

Observation and calculations

J-Ring Test Observations

Water cement ratio	Flowing of concrete in mm
0.4	8mm
0.5	7mm
0.6	5mm

Result for J Ring test

J-ring value for the given SCC sample is found to be 8mm for W/C ratio of 0.4, 7mmfor W/C ratio of 0.5 & 5mm for W/C ratio of 0.6

4.2 Compression StrengthTest

Introduction

Compressive strength is the ability of the material or structure to carry the loads on its surface without any crack or deflection. A material under compression inclines to reduce the size, while in tension, its size gets stretches. Compression strength test is carried on cube or cylinder as the ordinary specimen of the test. This test is often restrained on a universal testing machine.

The compressive strength was conducted as per IS 516 (1959). The concrete was mixed and casted in 100 x100x 100 mm^3 cube mould. The casted cube mould was compacted by vibration process for 1 minute. Then, the casted cubes are allowed to set for 24 hrs under roomtemperature.

After 24 hours, the casted cube moulds are removed and submerged in to the water bath. After 28 days curing, the cube samples are taken out from the water bath and tested form compressive strength in Compression Testing Machine

Assessment of test

The compression strength is used to determine the hardness of cubical specimen of concrete. Concrete specimen strength depends upon cement, aggregate, bond, W/C ratio, curing temperature and size of specimen. The compression strength is calculated by dividing the maximum load attained during the test by the cross-sectional area of the specimen.

formula

Compressive Strength = (P/A) (N/mm2)

- Weighing device
- Tools and containers for mixing
- Tamper (16 mm diameter & 600 mm height)
- Testing machine

- Three cubes (150 mm side)

Procedure for compression strength test

Prepare a concrete mix with the proportions such as 1:1.5:3 with w/c =0.5 by means of the hand mixing. Prepare three testing cubes, they should be clean and oiled. Metal molds should be sealed to their base plates to prevent loss of water. Fill the concrete in the cubes in three layers, tamping each layer of 35 blows with the help of tamper. Fill the molds completely, make the top evenly and cleanup of the real outside the cubes. Leave the specimen in the curing room for 24 hours. After that open the molds besides immerse the concrete cubes in a water basin for 7,14&28 days. Before testing check the testing, machine bearing surfaces are wiped clean. Carefully center the cube on the lower platen and ensure that the load will be applied to two opposite cast faces of the cube. Without shock, apply and increase the load continuously at a normal rate within the range of (0.2 N /mm 2.s to 0.4 N/mm 2.s) until no greater load can be sustained.

Compressive strength = (P/A) (N/mm2)

Where

P=Applied load(N)

A=Area of the specimen (mm 2)

Compressive strength values for Nominal Concrete

S.No	Mix Designation	Characteristic Compressive Strength(N/mm2)	
		7 Days	28 Days
I.	Nominal concrete	14.20	20.30

Result for compression strength test

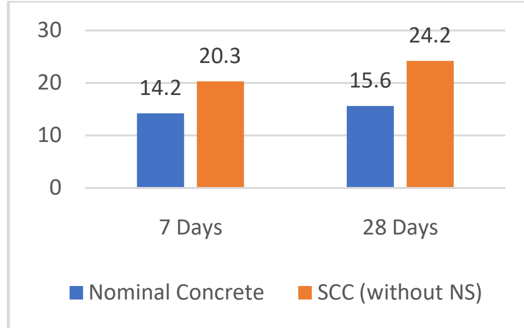
Compression strength test of the concrete cube for 7 days is 14.20**(N/mm^2)**

Compression strength test of the concrete cube for 28 days is 20.30**(N/mm^2)**

Compressive strength values for Self-compaction concrete

S. No	Mix Designation	Characteristic Compressive Strength(N/mm^2)	
		7 Days	28 Days
I.	SCC3%	15.60	24.21
II.	SCC 4%	17.74	26.10

Graph is 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 Nano-silica improves early strength also.



Compressive Strength of Nominal Concrete and SCC (without NS)

4.3. SEM Analysis (Scanning ElectronMicroscopy)

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 electrons 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

In this current study, the hydrated cement pastes obtained from the samples are subjected to SEM analysis. The range of scale used in SEM analysis was 5 µm with the resolution of x30000. The detailed process of sample preparations for SEM analysis is described below.

After Compressive testing was finished, the cube samples are crushed and the hydrated cement was collected from the innermost core of the concrete cube sample. The collected samples are sieved through 300µ sieve.

The sample preparation was done by cone and quartering method for reducing the sample size. The sample was dispensed on flat surface so that it takes on a conical shape. The top of the conical shape was flattened. The cone is divided into quarters. Two opposite quarters was discarded; the other two are combined. The process was repeated until the suitable sample size was reached the sample preparation process for micro structural analysis is pictured below.

We went to SEM lab in OUCT (Osmania University College of Technology) at Osmania University, Hyderabad, Telangana.

3 samples of specimen were tested. This sample contain of

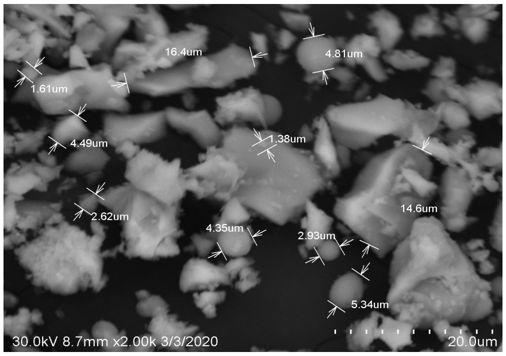
- Cement

- Nano silica
- Cement + nano silica gel.

Where cement + nano silica gel is made up by taking 300 grams of cement and 50 grams (0.3%) of nano silica 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

Fig.1 Example of a Cement image

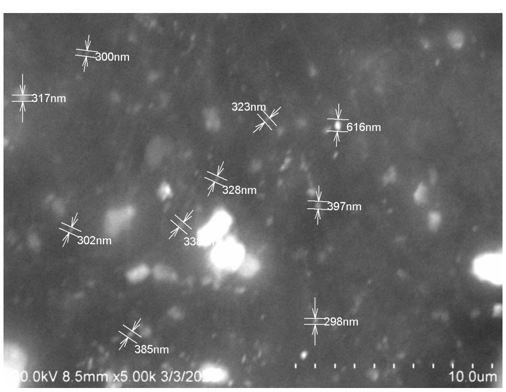


Specifications

- 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 of cement is in a range from 1.38 to 16.4 um.
- particles are in circular and irregular in shapes.
- Cement particlescontain void spaces in between them.

Sample 2

Fig.2 Example of a Nano silica gel image

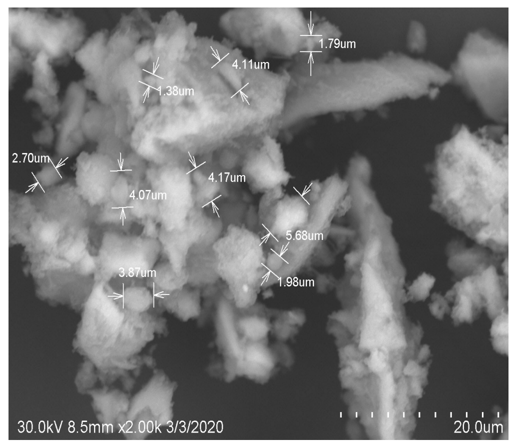


Specifications

- Pixel Size=19.84375
- Accelerating Voltage=30000 Volt
- Magnification=5000
- Working Distance=8500 um
- Emission Current=103000 nA
- Vacuum=60
- Micron Marker=10000
- Color Mode=Grayscale
- Condition=Vacc=30kV
- Mag=x5.00k
- WD=8.5mm
- Particles size of cement is in a range from 298 to 616 nm.
- particles are in circular and irregular in shapes.
- Surface tension between nano silica particles can be seen
- Particles of nano silica are closely packed and no space between particles is seen.

Sample 3

Fig.3Example of a Nano silica gel + Cement image



Specifications

- Pixel Size=49.60938
- Accelerating Voltage=30000 Volt
- Magnification=2000
- Working Distance=8500 um
- Emission Current=106000 nA
- Vacuum=60
- Micron Marker=20000
- Color Mode=Grayscale
- Condition=Vacc=30kV
- Mag=x2.00k
- WD=8.5mm
- Particles size of nano silica gel + cement is in a range from 1.38 to 5.68 um.
- particles are in angular, circular and irregular in shapes.
- Nano silica gel + cement particles are also closely packed they contain small amount void spaces in between them.

V. CONCLUSION

- From overall study, it is clear that the micro structural behaviour of concrete influences the strength characteristics of the mix. The addition of Nano materials changed the behaviour of microstructure of concrete and also influences the compressive strength of concrete mixes. From the test results of compressive strength, it was observed that replacement of concrete ingredients fairly improves on the strength of concrete mixes.
- In SEM Observations, the existence of mineral elements and their reactions with the supplementary materials are studied which gives an initiative to understand the microstructure of the concrete mixes. Based on the comparison of the microstructure of concrete mixes, it is clear that the hydration process in the mixes with supplementary materials was different from conventional concrete mix.
- SCC is recommended in complicated frameworks which have narrow places and congested steel bars, because it can flow throw this place very smoothly and without vibration and give the best compaction and surface finishes.
- Trial and error method where been used to design the SCC mix because there is no standard method for SCC in any institutes and concrete mix plants.
- SCC is recommended in high rise building because by using SCC the time for construction will be shorter and also the cost will be cheaper than using ordinary 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.
- When compared with normal concrete self compaction concrete shows a significant increase due to well compacted as density increases in concrete strength also increases.
- The presence of nano silica is determined using sem Analysis in 4.3. There is increase in strength due to the density increase in Nano Silica.

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