EXPERIMENTAL INVESTIGATION ON NANO CONCRETE WITH NANO SILICA AND M-SAND

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Abstract - *The influence of Nano-Silica on various properties of concrete is obtained by replacing the cement with various percentages of Nano-Silica. Nano-Silica is used as a partial replacement for cement in the range of 3%, 3.5%, and 10% for M20 mix. Specimens are casted using Nano-Silica concrete. Laboratory tests conducted to determine the compressive strength, split tensile and flexural strength of Nano-Silica concrete at the age of 7, 14 and 28 days. Results indicate that the concrete, by using Nano-Silica powder, was able to increase its compressive strength. However, the density is reduce compared to standard mix of concrete. The replacement of cement with 3% Nano-Silica results in higher strength and reduction in the permeability than the controlled concrete. The replacement of cement with Nano-Silica more than 3% results in the reduction of various properties of Nano-Silica concrete.*

Key Words: **Nano-Silica Powder, Strength, Self-Weight Reduce, Concrete, Plasticizers.**

1. INTRODUCTION

Concrete is the most widely used construction material in the world with the advancement of Nano technology. Nanotechnology has been applying to concrete production and has the capacity of improving the performance of concrete. In recent years, researchers have focused on the modified of concrete quality. It has been show to increase the mechanical and durability properties of concrete leading to development of novel and sustainable materials. However, the application of nanotechnology in concrete technology should go along with the availability of local materials. One interesting material to study is Nano silica produced from silica sand. Previous research on concrete using Nano silica has point out that improved workability and strength of concrete or mortar are to be expected.

Nano materials have been developed that can be applied to concrete mix designs to study the physical and mechanical properties of concrete. Nanotechnology is one of the most active research areas, which have wide applications in almost all the fields.

The fundamental processes that govern the properties of concrete are affect by the performance of the material on a Nano scale. As concrete is most usable material in construction industry it has been required to improve its quality. Recently Nano Technology has been introducing in Civil Engineering applications. One of the most used Nano material is Nano Silica (NS). The advancement made by the study of concrete at Nano scale has proved the Nano silica is much better than silica fume used in conventional concrete. Now, the researchers are capitalizing on nanotechnology to innovate a new generation of concrete materials that overcome the above drawbacks and trying to achieve the sustainable concrete structures. Evolution of materials is need of the day for improved or better performance for special engineering applications and modifying the bulk state of materials in terms of composition or microstructure or nanostructure has been the established route for synthesizing new materials. The newer materials can also be obtaining by intelligent and intermixing of existing materials at element level.

Without advancement of Nano technology, Nano materials have been developed that can be apply to concrete mix designs to study the physical, chemical and enhanced mechanical properties of concrete. Among the various developed or manufactured Nano materials such as Nano silica, Nano alumina, Nano titania, Nano zirconia, Nano Fe2O3 etc., carbon Nano tubes [CNT] or wires etc., the addition of Nano silica (NS) enhances the possibility for the reaction with calcium hydroxide (CH) to develop more strength carrying structure of cement: calcium silica hydrate (C-S-H) and also pore filling effect of Nano silica in the concrete. Hence, in this paper, a critical review on the influencing factors of Nano silica in concrete in detail and the research initiative towards the above task in the future have been provided. With characterization tools, the ability to gain a better understanding of the materials under study for their size, shape and morphology of crystalline or amorphous nature of those materials have been discuss.

1.1 NANOTECHNOLOGY

Nano Technology applied to concrete includes the use of nanomaterial's like Nano silica, Nano fibers etc. By adding the Nanomaterial's, concrete composites with superior properties can be produce. Addition of Nano silica (NS) in concretes and mortars results in more efficient hydration of cement. Due to the pozzolanic activity, additional calcium silicate hydrates are form to generate more strength and to reduce free calcium hydroxide. This also helps in reducing the cement requirement; NS improves the microstructure and reduces the water permeability of concrete thus making it more durable. Concretes with strengths as high as 100 MPa with high workability, anti-bleeding properties and short demolding time can be produced. Nano silica can be used as an additive to eco concrete mixtures.

2. OBJECTIVE

The objectives of this research project are to study-

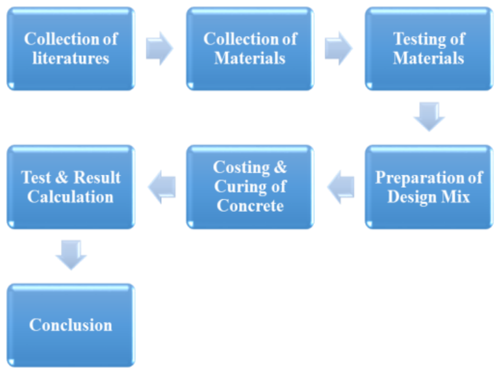
1. The project deals with concrete grades M 20.
2. Effects of Nano silica dosages on Compressive Strength of concrete.
3. Comparison of the test results of Conventional Concrete and Nano Silica concrete.
4. To explain the change in properties of concrete, if any by explaining the microstructure.
5. To study the fresh and harden properties (i.e. compressive strength, workability test) of NC with partial replacement of cement by Nano silica in different percentage such as 3%, 3.5%,10% are evaluate.
6. To study the fresh and harden properties of NC with fully replacement of sand by M-Sand and fully replacement of 20mm aggregate by 5-10mm Aggregates.
7. After evaluating the mechanical properties for the various mix and it is compare with best result.

3. METHODOLOGY

The main aim of this project is to determine experimental investigation on behavior of Nano material with 3% ratio. Controlled concrete slabs. The following steps are involved.

1. Initially the materials used are tested and the test results are shown in table.
2. Cubes, cylinders and prisms are casted for 3 percentage of Nano silica and they are used for determining the compressive strength split tensile strength and flexural strength of concrete using 3 percentage of Nano silica.
3. Tests are conducted using compression testing machine and also cylinders are tested using split tensile testing machine.
4. After determining the test results suitable percentage of Nano silica is determined to cast the Nano silica.
5. The replacement of cement with 3% Nano-Silica results in higher strength and reduction in the permeability than the controlled concrete.
6. The experimental works were conducted on concrete laboratory by applying load.

The following flow chart shows the methodology of this project



4.EXPERIMENTAL WORKS

4.1 CEMENT

The preliminary tests were conducted on cement, fine aggregate, coarse aggregate and the test results were obtained. Based on the results obtained the mix proportion for M 20 concrete is done.

The properties of materials tested are as follows,

S.No	Property	Value
1	Specific Gravity	3.15
2	Fineness	97.25
3	Initial Setting Time	45min
4	Final Setting Time	380min
5	Fineness Modulus	6%

4.2 PROPERTIES OF FINE AND COARSE AGGREGATE

Locally available natural sand with 4.75 mm maximum size was used as fine aggregate, having specific gravity, fineness modulus and unit weight. It is found that the sand collected is conforming to IS: 383-1970. Aggregate retained on 4.75mm sieve are identified as Coarse. The parent concrete is crushed through mini jaw crusher. During crushing it is tried to maintain to produce the maximum size of aggregate in between 20mm to 4.75mm. The physical properties of both fine aggregate and recycled coarse aggregate are evaluated as per IS: 2386 (Part III)-1963 and given in Table 4.2.1 but I have used 5mm to 9mm coarse aggregate.

4.2.1 PROPERTIES OF FINE AGGREGATE (M-SAND)

Fine aggregate used in this research is M- sand. Fine aggregates are the aggregates whose size is less than 4.75mm.

When rock is crushed and sized in quarry the main aim has generally been to produce course aggregate and road construction materials. M sand is defined as a purpose made crushed fine aggregate produced from suitable source materials. Manufactured sand has been produced by variety of crushing equipment's including cone crushers, impact crushers, roll crushers, road rollers etc., The raw material for

M sand production is the parent mass of rock. It is based on the parent rock that the chemical, mineral properties, texture, composition of sand would change.

Fig -4.2.1.1: M-SAND

Table -4.2.1.1: Properties of Fine Aggregate (M-SAND)

S.No	Property	Value
1	Specific Gravity	2.90
2	Fineness Modulus	5.2
3	Water Absorption	7%
4	Surface texture	Smooth

4.2.2 PROPERTIES OF COARSE AGGREGATE (5-10mm)

Coarse aggregate of nominal size of 5-10mm is chosen and tests to determine the different physical properties as per IS 383-1970. Test results conform to the IS 383 (PART III) recommendations.

Fig -4.2.1.1: Coarse aggregate (5-10mm)

Table -4.2.1.1: Properties of Coarse Aggregate (5-10mm)

S.No	Property	Value
1	Specific Gravity	2.89
2	Fineness Modulus	6
3	Water Absorption	0.83%
4	Particle Shape	Angle
5	Impact value	9%
6	Crushing Value	19

4.3 WATER

Drinkable water should be used for making concrete. Water should be free from acids, oils, alkalis, vegetables or other organic Impurities. Soft waters also produce weaker concrete. Water has two functions in a concrete mix. Firstly, it reacts chemically with the cement to form a cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Secondly, it serves as a vehicle or lubricant in the mixture of fine aggregates and cement.

4.4 PROPERTIES OF NANO SILICA

The average size of Nano silica was found to be 236 nm from Particle Size Analyzer, the report of which has been presented in the Appendix. The properties of the material are shown in Table 4.4.1.

Concrete strength is influenced by lots of factors like concrete ingredients, age, ratio of water to cement materials, etc. Nano-silica incorporation into concrete resulted in higher compressive strength than that of normal concrete to a considerable level.

4.4.1 FRESH PROPERTIES

Reduced setting times were observing by various researchers on incorporation of Nano-silica in concrete, which is same as, observed for pastes and mortar. In addition, decrease in initial and final setting time was observe on incorporation of ns in various quantities, with increase in viscosity and yield stress reported.

4.4.2 MECHANICAL PROPERTIES

Concrete strength is influence by lots of factors like concrete ingredients, age, and ratio of water to cement materials, etc. Nano-silica incorporation into concrete resulted in higher compressive strength than that of normal concrete to a considerable level. Li et al. (2004) reported 3-day compressive strength increase by 81% and at later stages, same trend was observing with 4% Nano-silica in high volume fly ash concrete. Naji Givi, Abdul Rashid, Aziz, and Salleh (2010) also reported higher compressive strength at all ages, for Nano-silica blended concretes up to maximum limit of 2% with average particle size of 15 and 80 nm. Same results were obtaining for split tensile and flexural strength. An increase of about 23–38% and 7–14% at 7 days and 28 days, respectively, in compressive strength of Nano-silica concrete was reported, whereas low increase of 9.4% (average) was reported for flexural strength.

4.4.3 DURABILITY PROPERTIES

Durability properties of concrete include aspects such as permeability, pore structure and particle size distribution, resistance to chloride penetration, etc. Investigations on Nano-silica concrete for its permeability characteristics showed that the addition of Nano-silica in concrete resulted in reduction in water absorption, capillary absorption, rate of water absorption, and coefficient of water absorption and water permeability than normal concrete. The pore structure determines the transport properties of cement paste, such as permeability and ion migration. Various researchers (Li, 2004; Zhang & Li, 2011; Zhang et al., 2012) have observed reduction in water absorption, capillary absorption, rate of water absorption and water permeability.

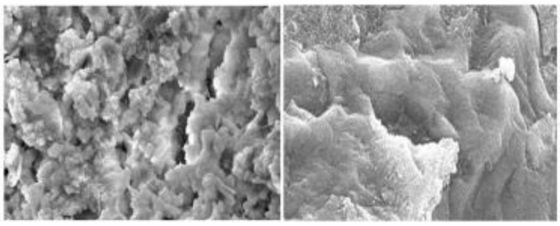


Fig -4.4.3.1: Comparison of the concrete density with and without Nano silica

4.4.4 APPLICATIONS

- High compressive strength concretes.
- High workability with reduced water/content ratio.
- Use of super plasticizing additives is unnecessary.
- Fills up all the micro pores and micro spaces.
- Cement saving up to 35-40%.
- As an additive for rubber and plastics
- As a strengthening filler for concrete and other construction composites

Fig -4.4.1: Nano silica

Table -4.4.1: Properties of Nano-silica

TEST ITEM	STANDARD REQUIREMENTS	TEST RESULTS
SPECIFIC SURFACE AREA(M2/G)	200+20	202
PH VALUE	3.7-4.5	4.12
LOSS ON DRYING @ 105 DEG.C(5)	<1.5	0.47
LOSS ON IGNITION @ 1000 DEG.C (%)	< 2.0	0.66
SIEVE RESIDUE (5)	< 0. 04	0. 02
TAMPED DENSITY g/L	40 – 60	44
SiO_2 CONTENT (%)	> 99. 8	99. 88
CARBON CONTENT (%)	< 0. 15	0. 06
CHLORIDE CONTENT (%)	< 0. 0202	0. 009
Al_2O_3	< 0. 03	0. 005
TiO_2	< 0. 02	0. 004
Fe_2O_3	< 0. 003	0. 001
SPECIFIC GRAVITY	2. 2 – 2. 4 (GENERALISED)	
PARTICLA SIZE	17 NANO	

4.5 PROPERTIES OF SUPER PLASTICIZERS

A super plasticizer is use to improve the workability of fresh Nano concrete. The dosage of super plasticizer also has an effect on the compressive strength of concrete. It also gives good surface finish and reduces setting time. It is generally acknowledging that the slump loss of fresh concrete at the construction site is one of the principal reasons associated with problems related to the strength and durability of concrete.
To produce high workability concrete without loss of strength. To promote high early and ultimate strengths by taking advantage of water reduction whilst maintaining workability.
To produce high quality concrete of improved durability and permeability.
At higher dosages, advantages can be take of the retardation of initial setting time of concrete especially in large pours.
Polycorboxylate or polymer based concrete admixtures are high range water reducing admixture (HRWR) without affecting workability. Superplasticizers, also known as high range water reducers, are chemical admixtures used where well-dispersed particle suspension is required. These polymers are used as dispersants to avoid particle segregation (gravel, coarse and fine sands), and to improve the flow characteristics (rheology) of suspensions such as in concrete applications.

4.5.1 FUNCTIONS

Their addition to concrete or mortar allows the reduction of the water to cement ratio, not affecting the workability of the mixture, and enables the production of self-consolidating concrete and high performance concrete. The strength of concrete increases when the water to cement ratio decreases.
High range water reducing (HRWRA) / super plasticizing admixtures are synthetic, water-soluble organic chemicals, usually polymers, which significantly reduce the amount of water required to achieve a given consistency in plastic concrete. This effect can be utilizing in two ways:

- To reduce water content to achieve increased strength and reduced permeability or improved durability.
- To achieve increased workability at the same water content.

With a slightly higher admixture dosage, both these effects can often be achieving in the mix. When high range water reducing admixtures are used to increase the workability or consistency of the concrete they are usually termed 'Super plasticizing admixtures' but these names are frequently interchanged.
High range water reducing admixtures function in a similar way to 'Normal Water Reducing Admixtures' but are more powerful in their cement dispersing action and can be used at higher dose without unwanted side effects such as air entrainment or retardation of set.

4.5.2 CHEMICAL STRUCTURE

PCEs (Polycorboxylate ether superplasticizer) are composed by a methoxide-polyethylene glycol copolymer (side chain) grafted with meth acrylic acid copolymer (main chain). The carboxylate group -COO-Na+ dissociates in water, providing a negative charge along the PCE backbone. The polyethylene oxide (PEO or MPEG) group affords a not uniform distribution of electron cloud, which gives a chemical polarity to the side chains. The number and the length of side chains are flexible parameters that are easy to change. When the side chains have a huge amount of EO units, they lower with their high molar mass the charge density of the polymer, which enables poor performances on cement suspensions. To have both parameters on the same time, long side chain and high charge density, one can keep the number of main-chain-units much higher than the number of side-chain-units.

4.5.3 WORKING MECHANISMS

PCE's backbone, which is negatively charged, permits the adsorption on the positively charged colloidal particles. Because of PCE adsorption, the zeta potential of the suspended particles changes, due to the adsorption of the COO- groups on the colloid surface. This displacement of the polymer on the particle surface ensures to the side chains the possibility to exert repulsion forces, which disperse the particles of the suspension and avoid friction.

These forces can be directly detected by the use of the atomic force microscopy (AFM), working with model substances in liquid environment.

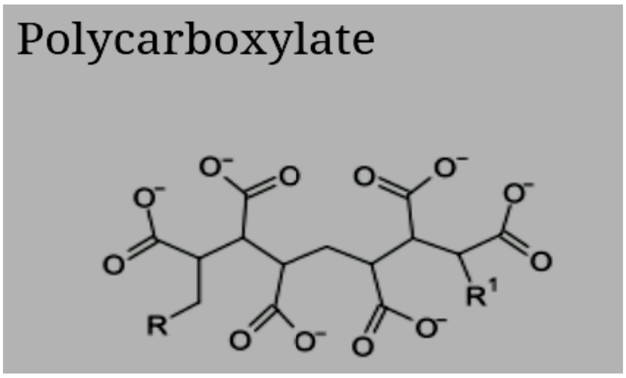


Fig -4.5.3.1: Polycorboxylate

Table -4.5.1: Properties of Polycorboxylate

Item	Unit	Specification
Appearance		Yellowish Viscous Liquid
Density	g/cm	31.0
PH		6.5~8.5
Solid Content	%	40
Cl-	%	≤0.01
Na^2SO_4	%	≤0.2
Cement Paste Fluidity	mm	≥250

5.PLANING FOR EXPERIMENT

In present study experimental program was designed to compare the mechanical properties i.e. compressive strength, workability of concrete with M20 grade of concrete and with partial replacement of ordinary Portland cement (43 grade) with Nano-silica with various percentages (3%, 3.5%, 10%). The optimized value is determined. Comparative mechanical strength properties of M20 grade concretes were studied with conventional.

This chapter represents the mathematical formulation for concrete mix design. Analytical study is made for 150 concrete cubes with different loading. The concrete mix design as per IS 10262- 2009 is computed. To check the constancy of concrete for each cube. The test performed such as workability and compressive strength is calculated.

Table -5: Batches of concrete mix

M20 Grade used	% Of Nano Silica
1	3%
2	3.5%
3	10%

5.1 MIX PROPORTION FOR M20 CONCRETE

Concrete mix design is the process of finding right proportion of cement, sand and aggregates for concrete to achieve target strength in structures. So concrete mix design can be state as concrete Mix = Cement Sand: Aggregates.

For 1 m^3
Cement = 1440 Kg/m^3
Fine aggregate = 1600 Kg/m^3
Coarse aggregate = 1450 Kg/m^3
Water content = 1000 Kg/m^3
C: FA: CA = 1:1.5:3
The mix proportion for M20 concrete is calculate using IS 456:2000, IS 10262:2009. Superplasticizer is also adding to increase the workability of concrete.
150 x 150 x 150mm cube is = 3.375 x 10^{-3} m^3
Cement = 1.536Kg
Fine aggregate = 2.46 Kg
Coarse aggregate = 4.453Kg
Water cement Ratio = 0.45%
Water content = 0.6885 Kg (or) Li

5.2 MIX PROPORTION FOR M20 CONCRETE WITH NANO SILICA

Cement = 1.494Kg (3%) Silica = 46.2g
Cement = 1.486Kg (3.5%) Silica = 53.9g
Cement = 1.386Kg (10%) Silica = 154g
Fine aggregate = 2.46 Kg
Coarse aggregate = 4.453Kg
Water cement Ratio = 0.45%
Water content = 0.6885 Kg (or) Li

5.2.1 WATER CEMENT RATIO

Water cement ratio depends on exposure (MODERATE) as per table 5 of IS 456-2000 (p.no 20). Maximum water cement ratio = 0.5. Based on experience adopt water – cement ratio = 0.5-0.05 = 0.45

5.2.3 POLYCORBOXYLATE MIX RATIO

Polycorboxylate ether is a second invention compound, which produce very strong and high gains.PCE-811 is the best solution for creating the precast solid constituents along with all procedures, including Rheoplastic or super feasible concrete. This concrete element having a low water folder proportion, liquid consistent, long time powers, no segregation and consequently high early. This plast PCE-811 will be producing the Rheodyanamic material, capable of self-compacting and reinforcement with no aid of the vibration.

- 100ml water and add 10g Polycorboxylate powder.
- Water are heat in 10 min at 80° C.
- Then Polycorboxylate added then cooled in open air.

Fig -5.2.3.1: Polycorboxylate liquid

6.COASTING AND CURING OF CONCRETE

The concrete shall be mix in a room having an ambient temperature of (25 ± 5) °C and a relative humidity of not less than 50 % if the aggregate is dry, it shall be soaked with some of the mixing water before adding other materials. Loss of water by evaporation shall be avoid. After the dry aggregate has been, allow to soak, admixtures if required may be add together with the remaining portion of the mixing water, except in the case of admixtures that need to be add shortly before using the concrete. The concrete shall be mixed, preferably by machine or alternatively by hand, in such a manner as to avoid loss of water or other materials.

6.1 HAND MIXING

The concrete batch shall be mix on a sample tray with a square-mouthed shovel or similar suitable implement, using the following procedure:

The cement and fine aggregate shall be mix dry until the mixture is uniform. The coarse aggregate shall be adding and mixed dry with the cement and fine aggregate until the coarse aggregate is uniformly distribute throughout the batch. The water shall then be added and the whole mixed for at least three minutes and until the concrete appears to be homogeneous.

Fig -6.1.1: Try mixing

Fig -6.1.2: Water & Polycorboxylate mixing

Fig -6.1.2: Coasting concrete in mould

6.2 CURING OF CONCRETE

Curing is the maintenance of a satisfactory moisture content and temperature in concrete for a period immediately following placing and finishing so that the desired properties may develop. The need for adequate curing of concrete cannot be overemphasized. Curing has a strong influence on the properties of hardened concrete; proper curing will increase durability, strength, water tightness, abrasion resistance, volume stability, and resistance to freezing and thawing and deicers. Exposed slab surfaces are especially sensitive to curing as strength development and freeze-thaw resistance of the top surface of a slab can be reduce significantly when curing is defective.

When Portland cement is mix with water, a chemical reaction called hydration takes place. The extent to which this reaction is completed influences the strength and durability of the concrete. Freshly mixed concrete normally contains more water than is required for hydration of the cement; however, excessive loss of water by evaporation can delay or prevent adequate hydration. The surface is particularly susceptible to insufficient hydration because it dries first. If temperatures are favorable, hydration is relatively rapid the first few days after concrete is place; however, it is important for water to be retained in the concrete during this period, that is, for evaporation to be prevented or substantially reduced.

Fig -6.2.1: Curing of concrete cube

Fig -6.2.2: Curing of concrete cube

7.CONCRETE TEST AND RESULT

7.1 TEST SPECIMENS

The compressive stress, split tensile strength and flexural strength of concrete are determined by casting cubes of size 150x150x150 mm, cylinders of size 300x100 mm and allowed for 7, 14, 28 days curing, and the test results were obtained for 3 percentage of Nano silica.

This section describes the results of the test program to establish the mechanical properties of the normal as well as Nano silica added to the concrete with different percentage to the weight of the cement. Concrete mixes detailed in the preceding section. Mixing of ingredients of concrete is done for the mix proportion for M_{20} grades of concrete mixes by adding Nano silica with different percentages in the range of (3%, 3.5% 10%).

7.2 Cube Compressive Strength

One of the important properties of concrete is its strength in compression. The strength in compression has a definite relationship with all the other properties of concrete i.e. these properties are improving with the improvement in compressive strength. The size of the mould is usually 150x150x150 mm. Concrete cubes are tested for 7,14 and 28 days' strength as per IS: 516-1959 (Part 5) for testing of concrete cubes. Rate of application of Compressive load is 1.40 KN/cm2/min and is teste in a compression-testing machine.

Fig -7.2.1: compression-testing machine.

Fig -7.2.1: compression-test on cube

Table -7.2.1: Compressive stress of controlled concrete cubes and Nano silica cube

Specimen Nano silica (%)	Compressive stress in 7 days (N/mm2)	Compressive stress in 14 days (N/mm2)	Compressive stress in 28 days (N/mm2)
CC	13.5	16	19.75
3%	18.77	20.9	23.11
3.5%	16	18.5	20
10%	13	15.2	17

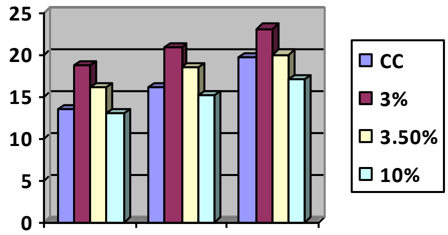


Fig -7.2.1.1: shows the compressive stress of cubes

7.3 Splitting Tensile Strength of Cylinder

This is also sometimes referred as, "Brazilian Test". This test was developing in Brazil in 1943. At about the same time this was also independently develop in Japan. The test is Carrie out by placing a cylinder specimen horizontally between the loading surfaces of a compression test machine and the load is applying until failure of the cylinder, along the vertical diameter.

The loading condition produces a high compressive stress immediately below the two generators to which the load is applied. However, the larger portion corresponding to depth is subject to a uniform tensile stress acting horizontally. It is estimated that the compressive stress is acting for about 1/6 depth and remaining 5/6 depth is subjected to tension.
The splitting test is simple to perform and gives more uniform results than other tension tests. Strength determined in the splitting test is believe to be closer to the true tensile strength of concrete, than the modulus of rupture. Splitting strength gives about 5 to 10% higher value than the direct tensile strength.

Fig -7.3.1: Split-tensile test Machine

Fig -7.3.2: Split-tensile test of concrete

Table -7.3.1: Split Tensile Strength of controlled concrete Cylinders and Nano silica concrete cylinders

Specimen Nano silica (%)	Split Tensile Strength in 7 days (N/mm2)	Split Tensile Strength in 14 days (N/mm2)	Split Tensile Strength in 28 days (N/mm2)
CC	1.98	2.35	3.0
3%	3.4	3.75	4.2
3.5%	2.7	2.85	3
10%	2	2.3	2.8

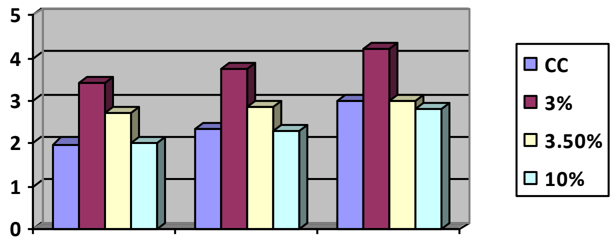


Figure -4.7.2: shows the compressive stress of cubes

7.4 ACID RESISTENT TEST IN CONCRETE

Concrete is defining as a mixture of cement, sand, gravels, water and sometimes admixtures and additives. Concrete has long been use in civil engineering industry for construction of foundations, footings, retaining walls, slabs, pavements, tunnels, bridges, basins, canals, dams, drains, sewerage lines and many other structures and structural members. Concrete is the backbone of any country's infrastructure. Concrete hardens and gains strength within days. Its relative low cost, ease of application and relative long-term service life compared to other materials is the main cause of its popularity. The disadvantage of using concrete is that the microstructure of concrete allows the penetration of water and other destructive species that will cause premature failing of the concrete surface. A permeable concrete will allow infiltration of aggressive agents (chlorides, carbon dioxide and acids) to the steel reinforcement bars causing complete failure of the structure.

The concrete cube specimens of various concrete mixtures of size 150 mm were cast

In addition, after 28 days of water curing, the specimens were remove from the curing tank in addition, allowed to dry for one day. The weights of concrete cube specimen were taken. The acid attack test on concrete cube was conducted by immersing the cubes in the acid water for 90 days after

28 days of curing. Hydrochloric acid (HCL) with pH of about 2 at 5% weight of water was added to water in which the concrete cubes were stored. The pH was maintained throughout the period of 90 days. After 90 days of immersion, the concrete cubes were taken out of acid water. Then, the specimens were teste for compressive Strength. The resistance of concrete to acid attack was found by the percentage loss of weight of Specimen and the percentage loss of compressive strength on immersing concrete cubes in acid Water. Figure 7.4.1 represents the Percentage loss in Weight of M20 due to Acidity respectively. Figure 7.4.2 represents the Percentage loss in

Strength of M20 due to Acidity respectively.

Figure -7.4.1: Acid - test of concrete

Fig -7.4.2: Acid - test of concrete

Fig -7.4.3: Acid Reaction of concrete

8. CONCLUSIONS

The workability of concrete with partial replacement of Nano silica, which is decreasing by increasing the amount of Nano silica. Nano silica absorbs the quantity of mixing water, reducing the workability.

3.0% of Nano silica appears to be the optimum in the high strength concrete mixes like M20. The highest compressive strength with 3.0% of Nano silica.

In the case of split tensile strength, 3% of Nano silica gives the highest value. The highest strength with 3% of Nano silica.

Coarse aggregate 5-10mm used its improve the concrete strength and reduce the quantity with the introduction of Nano materials like Nano silica in concrete it is expected that better composites of concrete can be prepared to answer any kind of situation faced by the structures.

The percentage increase in the compressive strength for 3.5% and 10% replacement of cement is decrease for both batches after that 3% replacement of cement is increase up to 18.77 and 21.666.

Nano silica can also cover the path to reduce the cement content in concrete than the conventional mixes while maintaining same strength characteristics, which will lead into the production of concrete.

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