A STUDY ON PROPERTIES OF STRENGTH AND DURABILITY OF COCNRETE USING ADMIXTURES

[1] G VENKATA SUSHANTH, [2] B FAYAZ
[1]Student, [2]Assistant Professor
Department of Civil Engineering
PVVKIT

ABSTRACT

The present study is the effect of nano silica (NS) on the strength of concrete containing different flyash contents ranging from 0% to 30% (by weight) as partial replacement of cement. The compressive strength of concretes is measured 28 days. The replacement of cement by mineral admixtures in concrete has been of increasing interest in the construction industry. Several of the potential replacements, such as fly ashclass F, lower the compressive strength of concrete at early age. This project investigates the useof nano silica to compensate for such loss of compressive strength. An experimental design involving mixtures of cement, fly ash and nanosilica, in addition to water/binder ratio as other factor, is proposed to study combined effect on the compressive strength, split tensile strength and durability properties of concrete.

Keywords: Fly ash, Nanosilica, Compressive strength , Split tensile strength.

I. INTRODUCTION

The demand for building materials like cement, sand and coarse aggregate is increasing in the country due to the growth of population, economy, and living standards of the people. Cement production in the country is assessed to be 347 metric tons per annum. Cement production grew by 5% every year.

Cement concrete is the most chosen construction material for its wide variety of skills, ease in production, and use. There are three aspects in the use of concrete. The first one is the durability aspect. The second aspect is the economy in construction by improved design and cost reduction in cost of materials. The third aspect is energy preservation and environmental protection. We can satisfy these three aspects by using fly ash in concrete.

Fly ash, also known as flue-ash, is one of the remains generated in combustion and contains the fine particles that rise with the flue gases. Ash that does not rise is named bottom ash. In an industrial context, fly ash generally refers to ash produced during the combustion of coal. Fly ash is generally caught by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal-fired power plants, and together with bottom ash removed from the bottom of the furnace is in this case jointly known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash comprises substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline) and calcium oxide (CaO), both being endemic ingredients in many coal-bearing rock strata.

Currently about 250 million tons per annum of fly ash is generated in India as a by-product of coal consumed in the thermal power plants. The thermal power plant is the only source to produce about 65% of the total electricity produced in our country. Investigation on the utilization of fly ash in cement mortar is carried out by many authors reported in the literature. Several million tons of coal for generating electricity is being spent in India out of which 40% of coal is accounted for generating of fly ash as a by-product. By the year 2010 more than 180 million tons of flyash would be produced every year . The type of flyash collected at the bottom of boiler furnace having lesser fineness and high carbon content is called bottom flyash. The finest flyash is called dry flyash, collected from different electrostatic precipitators (ESP) in dry form. While the ash mixed with water, slurry and drained out in ponds is referred as pond flyash.

The mineralogical studies of fly ash discloses that silica is present in crystalline forms of quartz (sio3) and partially it is associated with alumina as mullite (2AL2O32Sio2), the rest being mostly in the glassy phase. The huge amount of flyash imposes challenges for its disposal and managing. At present flyash is disposed in slurry form in large ponds accomplished by Thermal power corporation plant units. A small percentage that is 3% to 5% of flyash is being used in India while in other countries the percentage of utilization is 30% to 80%, whatever be the type of flyash, it causes some of the types of pollution and air born diseases such as silicoses, fibrosis of lungs, bronchitis etc. Due to the existence of toxic metals in flyash, it causes water pollution through percolation. Its disposition on agricultural land affects the horticulture and also made the soil uncultivable. It also adversely affects the civil and mechanical structures. It also causes silting and other problems for human and aquatic life, therefore, it cannot be disposed in sea or river . Flyash is being consumed (tones/day) by several establishments in production of cement,bricks, cellular blocks, asbestos sheets, filling low lying areas and construction of roads .

The impacts of flyash usage in road works including embankments are wind erosion, surface water erosion and leaching of toxic heavy metals into water bodies including underground aquifers. The sub base/base layers of roadways constructed using flash need to be covered with black top to prevent percolation of rain water to avoid ground water interference and to keep sub grade dry as per standard road construction practices. It is to be ensured that leaching of heavy metals is minimized. Flyash may sometimes accidentally comes in contact with running water and ground water and the flyash water mixture is basic in nature (8<PH<10) which tends to limit the heavy metal leaching.

In some cases, such as the burning of solid waste to create electricity ("resource recovery" facilities a.k.a.waste-to-energy facilities), the fly ash may contain higher levels of toxins than the bottom ash and mixing the fly and bottom ash together brings the proportional levels of toxins within the range to qualify as safe waste in a given state, whereas, unmixed, the fly ash would be within the range to qualify as harmful waste.

1.1 Chemical composition and classification

Component	Bituminous	Subbituminous	Lignite
SiO_2 (%)	20-60	40-60	15-45
Al_2O_3 (%)	5-35	20-30	20-25
Fe_2O_3 (%)	10-40	4-10	4-15
CaO (%)	1-12	5-30	15-40
LOI (%)	0-15	0-3	0-5

Fly ash material hardens while suspended in the exhaust gases and is collected by electrostatic precipitators or filter bags. Since the particles harden rapidly while suspended in the exhaust gases, fly ash particles are generally spherical in shape and range in size from 0.5µm to 300 µm. The major consequence of the quick cooling is that only few minerals will have time to crystallize and that mainly amorphous, quenched glass remains. Nevertheless, some refractory phases in the pulverized coal will not melt (entirely) and remain crystalline. In concern, fly ash is a heterogeneous material. SiO2, Al2O3, Fe2O3 and occasionally CaO are the main chemical constituents present in fly ash. The mineralogy of fly ashes is very different. The main phases encountered are a glass phase, together with quartz, mullite and the iron oxides hematite, magnetite. Other phases often identified are cristobalite, anhydrite, free lime, periclase, calcite, sylvite, halite, portlandite , rutile and anatase. The Ca-bearing minerals anorthite, gehlenite, akermanite and various calcium silicates and calcium aluminates identical to those found in Portland cement can be identified in Ca-rich fly ashes.

The above concentrations of trace elements vary according to the kind of coal combusted to form it. In fact, in the case of bituminous coal, with the notable exception of boron, trace element concentrations are generally similar to trace element concentrations in unpolluted soils.

Two classes of fly ash are defined by ASTM C618: Class F fly ash and Class C fly ash. The chief difference between these classes is the amount of calcium, silica, alumina, and iron content in the ash. The chemical properties of the fly ash are largely influenced by the chemical content of the coal burned (i.e., anthracite,bituminous, and lignite).

Not all fly ashes meet ASTM C618 requirements, although depending on the application, this may not be necessary. Ash used as a cement replacement must meet strict construction standards, but no standard environmental regulations have been established in the United States. 75% of the ash must have a fineness of 45 µm or less, and have a carbon content, measured by the loss on ignition (LOI), of less than 4%. In the U.S., LOI needs to be under 6%. The particle size distribution of raw fly ash is very often fluctuating constantly, due to changing performance of the coal mills and the boiler performance. This makes it necessary that, if fly ash is used in an optimal way to replace cement in concrete production, it needs to be processed using beneficiation methods like mechanical air classification. But if fly ash is used also as a filler to replace sand in concrete production, unbeneficiated fly ash with higher LOI can be also used. Especially important is the ongoing quality verification. This is mainly expressed by quality control seals like the Bureau of Indian Standards mark or the DCL mark of the Dubai Municipality.

II. LITERATURE REVIEW

2.1 GENERAL:

Now-a-days the Substitute Pozzolonic materials are widely used by the researchers and common users to attain greater strength at curing stages. By using the By-products of Thermal industries and also by some other advanced technologies of using waste products are encouraged vastly. The industrial By-products like Nano-Silica (NS) and Fly Ash (FA) are used for the development of strength properties and also to improve the durability of concrete. One of the investigation techniques to reduce the cement quantity in concrete preparation is by using Fly Ash (FA) and Nano-Silica (NS).

The experimental investigations carried by various researchers on replacement of cement using Nano-Silica (NS) and Fly Ash (FA) are presented in the following literature review.

2.2 REVIEW OF LITERATURE

- "THOMAS ET AL. [1999]"- The first ever researcher to reported that the Concrete strength decrement at early stages, but slight increases at curing periods. And also he used Silica-Fume a waste By-product as a replacing material to improve strength properties and given the report that the using Silica-Fume the results are better at earlier stages and with further increment in content of replacing material may gives same results without replacing materials especially at later stages. Hence, he suggested that the replacement of cement with Fly Ash (FA) and Silica-Fume (SF) is an improved technique for strength development.
- "BENTZ. D ET.AL [2010]" – Reported about the Fly Ash usage in high volumes in concrete. These experimental tests are compared with the Controlled Concrete and Fly Ash replaced contents of 15-70% and are attained a target slump test value of 200mm ± 5mm. He used super plasticizers to control the water content upto optimum level and attain a reduced water contents to 18% for water cement ratios of 0.45, 0.5, 0.6 and 0.65. The Fly Ash replaced content, Setting periods and strength results are compared for both Controlled concrete with the replaced concrete at 7, 28 and 56 days of curing.
- "JAGADESH S [2006]" - Reported the merits of using Fly Ash as Supplementary Cementing Material (SCM) in Fibre cement sheets. Fly ash containing fibre cement sheets exhibits low early strength even at an optimal dosage of 12-25%.Various procedures that is suitable to increase the percentage of Fly Ash by calcium – enrichment and application of calcium on to coal while burning process itself.
- "CARETTE.G ET.AL [2010]" – For the research regarding early ages strength development he used a combination of Silica Fume and Fly Ash in condensed state. The present investigation carried has given the

results that on early stages of concrete with 30% of Fly Ash may develops strength with low amounts of Silica Fume addition. The quantities of Silica-Fume added are ranging from 0-20% by the weight of the cement and Fly Ash. After completion of concrete specimen preparation they are tested for Compression with 240 cylinder specimens and 180 prism specimens for Flexural Strengths. But it is observed that by incorporating 30% Fly Ash and 70% cement in concrete mix had greater strength properties 7 days, 28 days and 56 days. But the compressive strength may loss a quite with increase in Fly Ash so that it can be attained by adding a 0.01 quantity of Silica Fume in condensed state for water cement ratios of 0.4, 0.5, 0.55 and 0.6.

III. MATERIAL PROPERTIES

3.1 GENERAL ASPECTS

In general concrete is widely used construction material which comprises of cement, Fine aggregates, coarse aggregates and water. Due to hydration of cement the stronger mass is formed with cement and water paste. The voids in the cement and water paste is filled by the both coarse and fine aggregates.

We know that the plastic nature of cement tends it to mould in any form easily. So, the moulded cement can be smoothened using a trowel. Major precautionary steps are to be followed to control the rapid loss in water content and also to avoid pores in concrete which results in decrement in strength. The two affects of Segregation and bleeding are controlled in concrete. The cement and water paste only defines the quality of the concrete specimen. The proportions which we use in mix design are also plays an important role in determining the characteristics of concrete. An air gaps retarding agent is to be mixed with this so that the pores in the concrete can be eradicated which results in density increment.

Due to the Tri-calcium Silicates present in the concrete may gradually increases the strength properties. Fine aggregates used to concrete preparation are advisably rough, angular and but now-a-days we are using only rounded grains. Because we are using stone which are angularly available which attains a density of 2,500 Kg/m3. A steel bar or Mesh are introduced in concrete because of its weaker strength characteristics in tension zone.

3.2 CEMENT

As per the specifications of code IS: 8112-1989 (ordinary Portland cement) of 43grade is used for the present investigation. The cement utilized should be free of lumps and fresh and various investigations carried out should be as per Indian Standard Code specifications as shown in table-1

Table 1: Physical Properties of Cement

S.No	Property	Test result	As per IS8112:1989 (Limitations)
1	Specific Gravity	3.15	2.5-3.15
2	Normal Consistency	32%	28-35
3	Setting Time (a)Initial Setting time (b)Final setting time	120 minutes 6 hours	Not less than 30 minutes and not more than 600 minutes

3.3 FINE AGGREGATES

Available sand from Local River confirming to IS: 383-1970 was used as fine aggregates in concrete preparation.

The fine aggregates passing through 4.75mm IS sieve is utilised as shown in table-2 and sieve analysis is shown in table-3,

Table 2: Properties of Fine aggregate

S.No	Physical property	Fine Aggregate Values
1	Specific Gravity	2.70
2	Fineness Modulus	2.8
3	Bulk Density (a)Loose State (a)Compacted State	 16.75 kN/m^3 17.15 kN/m^3
4	Grading of Sand	Zone – II

Table 3: Sieve Analysis of Fine Aggregate

Size Of Sieves	Weight Retained (gm)	Cumulative Retained %	Cumulative Passing %	Zone - Specifications as per IS:383-1970 for % Passing			
				I	II	III	IV
4.75 mm	20	2.0	98.0	90-100	90-100	90-100	95-100
2.36 mm	35	5.5	94.5	60-95	75-100	85-100	95-100
1.18 mm	350	40.5	59.5	30-70	55-90	75-100	90-100
600 µ	250	65.5	34.5	15-34	35-59	60-79	80-100
300 µ	200	85.5	14.5	5-20	8-30	12-40	15-50
150 µ	45	90.0	10.0	0-10	0-10	0-10	0-10
Pan	100	100	0	---	---	---	---

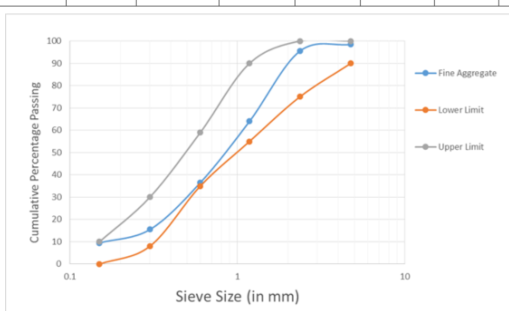


Figure 4Particle-Size distribution of Fine Aggregate (Zone-II)

3.4 COARSE AGGREGATES

Coarse aggregates of nominal sizes 20mm and 10mm locally accessible demolished stone acquired from the quarries confirming to IS383-1970 was utilized in the proportion of 1.5:1.0 as shown in table-4

Table 4: Properties of Coarse aggregate

S.No	Physical properties	Fine Aggregate Values
1	Specific Gravity	2.65
2	Bulk Density (a)Loose State (b)Compacted State	 13.15 kN/m^3 15.68 kN/m^3
3	Water Absorption	0.3%
4	Fineness Modulus	7.85

3.5 WATER

Water used for casting and curing of concrete specimens should be free from all types of contaminants like alkalis, salts, acids, organic matter, oils and other pollutants. The water with impurities can adversely influence the strength properties of concrete.

3.6 FLY ASH

For the present investigation Fly Ash of "Class-F" obtained from the Thermal Power plant is used. The Fly Ash proportions of 20% and 30% by weight of cement are used. The Physical properties of Fly Ash are as shown in table-5.

Figure 5 Fly Ash Sample

Table 5: Properties of Fly Ash

S.No.	Properties	Values
1	Silica (SiO_2)	56.87 %
2	Aluminium trioxide (Al_2O_3)	27.65 %
3	Ferric oxide ($Fe_2O_3 + Fe_3O_4$)	6.28 %
4	Titanium dioxide (TiO_2)	0.31 %
5	Magnesium oxide(MgO)	0.34 %
6	Loss of ignition (LOI)	4.46 %
7	Specific gravity of Fly Ash	2.12

3.7 NANO-SILICA

Nano-Silica utilised in this investigation is a Pozzolanic colloidal silica emulsion. It is a better Pozzolanic material because of its high content of Amorphous Silica (>99%) and also their reduced spherical size of order 15 nano meters-50 nano meters.

In our present investigation we used the Nano-Silica contents as 2%, 4% and 6%. The properties of Nano-Silica is shown in table-6

Table 6: Properties of Nano-Silica

S.NO.	Properties	Actual results
1	Nano solids	39.5-41%
2	Ph	9-10.0
3	Specific Gravity of the sample	1.29-1.31
4	Sample Texture	White Liquid (Milky liquid)
5	Dispersion	Water

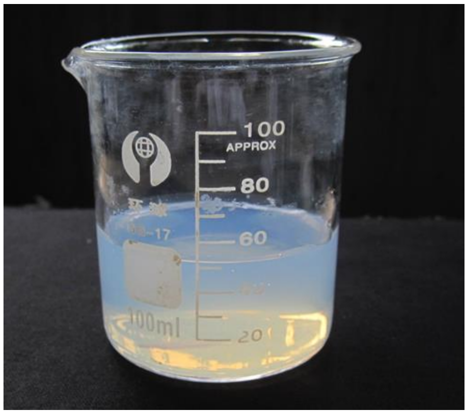


Fig 6Nano-silica sample

IV. MIX DESIGN

4.1 GENERAL ASPECTS

In this study the proportions of various concrete constituents elements required to form a concrete of required durability, strength and workability. It is design economically as high as possible. The two stages of Plastic and Hardened states of concrete with proportions of cement, Fine aggregates, coarse aggregate and water are calculated. At low workability state it is properly vibrated and compacted to optimum workability.

Based on Quality and Quantity of ingredients to form concrete are generally considered from the compressive strength of concrete and the proportions of water, aggregates of Fine [FA] and Coarse aggregates [CA] are attained. The manufactured cost of concrete is based on the material cost, labour force and batching plant. It is preferable to change cost of concrete is done only by reducing the cement content.

The characteristic strength of concrete is related to the cost of concrete specimen. One of the main thing i.e., quality control maintained while mixing also influences the cost of concrete. The major cost of concrete is depends upon the size and shape of the aggregates. the workability is maintained to control cost of concrete mix which also depends on the compaction value.

4.2 MIX DESIGN

Codal provisions and requirements of Mix design

The following are the steps to be followed while selecting the ingredients for mix design are:

a) For structural provision the minimum Compressive Strength is to be considered.

b) For optimum compaction the required workability is attained.

c) To get optimum durability the W/C ration and cement quantity is found.

d) The various factors that affect the concrete are to be identified and rectified.

The various factors affecting the mix design are:

(i) Compressive Strength:

The concrete main property i.e., compressive strength may affects the other factors of Mix design at hardened state. For nominal W/C ration the minimum or mean compressive strength at 28days of curing age is found. The degree of compaction is also of the factor that influences the strength of concrete. But as per Abraham's law of strength and water-cement ratios are inversely proportional.

(ii) Degree of Workability:

Size, Steel reinforcement and compaction techniques are the three factors on which the workability factor depends. The full compaction in case of very narrow sized reinforced section can be attached only to get workability to optimum.For the Embedded mild steel sections are also based on workability only and also depend on the method of compaction.

(iii) Durability of Concrete:

The main property of the concrete i.e., resistant to the aggressive environmental situations are rely on the durability property. Durability in case of low strength concrete is low and in case of High strength concrete of high durability.But in some cases of high strength is not only required but also exposure condition is needed for more durability nature and also based on the W/C used.

(iv)Nominal Size of Aggregates:

The maximum size of aggregates is one of the important aspects on which the workability of concrete depends. It is investigated that the workability of concrete is increases gradually with the size of aggregates for smaller water-cement ratio.

The nominal provisions of aggregates are confirming to the codes of IS 456:2000 and IS 1343:1980 shows that the maximum sizes of aggregates are preferred.

(v) Aggregate grading and type of aggregate:

In some cases the workability and water-cement ratio of particular grading influences. For Lean mix of concrete the coarse aggregates are preferred than very lean mix is not advisablebecause of its finer material to make a specimen of concrete.

Aggregate selection also plays a vital role in the strength properties, workability and also water-cement ratio. By uniform grading only the mix design can be accurate for different sizes of aggregates.

(vi) Controlled concrete:

The variation in the test results are mainly depends upon the degree of control. Because of the proportions of mix ingredients, batching, curing, testing and mixing which varies the strength properties of concrete. The factor controlling this difference is termed as quality control.

4.3 MIX DESIGN OF M35 GRADE OF CONCRETE

Table 7: Proportioning of M35 grade concrete mix

Type of Cement	Ordinary Portland Cement 43 Grade
Maximum Nominal size of Aggregate	20 mm
Minimum content of Cement	340 kg/m^3
Maximum Water Cement ratio	0.45
Specific Gravity of Cement	3.15
Specific Gravity of Fine aggregate	2.70
Specific Gravity of Coarse aggregate	2.65

V. EXPERIMENTAL INVESTIGATION

5.1 GENERAL ASPECTS

Our present study mainly discuss about the various strength properties like Compressive Strength, Tensile Strength, Flexural Strength and Modulus of Elasticity for M35 Grade of Concrete with partial replacement of cement by using Nano-Silica (NS) and Fly Ash (FA). The proportions suggested for the present investigation are Nano-Silica with 2.0%, 4.0% and 6.0% and Fly Ash 20% and 30% for making concrete specimens by weight of cement.

5.2 PREPARATION OF DESIGN MIX

The mix design of concrete mainly depends upon the properties of materials used for mix design. In the first step the Fly Ash and cement are mixed thoroughly and make a fine powder and then water and Nano-Silica are added with similar proportion. The two proportions are mixed uniformly and then the colour is maintained simultaneously to get required consistency and ready for casting. By the codal provisions of IS 1199:1959 the tests are to be carried i.e., Slump cone test and compaction factor test.

5.3 TEST SPECIMENS

The concrete specimens are,

a) Cubes- 150mm x 150mm x 150mm
b) Cylinders- diameter (150mm) and height (300mm)
c) Prisms – 100mm x 100mm x 500mm.

The concrete specimens are tested at different curing periods (3, 7, 28 and 56days). After the curing of specimens they are tested for various mechanical strength tests at 28 days. As per the specifications of IS516:1959 the loading rate is to be carried.

5.4 CURING PROCEDURE

The concrete specimens after casting they are kept aside for 24 hours and then the specimens are removed from mould at optimum temperature. A detailed marking is to be done on specimen to identify the specimen. After this the specimens are placed in water to keep moisture content in control. After the successful completion of curing the specimens are make ready to test for curing periods of 3, 7, 28 and 56 days of age.

5.5 TESTS ON NANO-SILICA (NS) AND FLY ASH (FA) CONCRETE

5.4.1 COMPRESSION STRENGTH TEST

The strength property test in which the very important test is compressive strength of cube or cylinder specimens are ease to performed and also relates it to the controlled concrete confirming to the IS: 516-1959 and these specimens are underwent compression test by using CTM machine as shown below:

Fig: 5.4.1 Compression Strength Testing Machine

VI. RESULTS AND DISCUSSIONS

GENERAL ASPECTS

For M35 Grade of Concrete with partial replacement of cement by using Nano-Silica (NS) and Fly Ash the standard tests were conducted on hardened concrete specimens to obtain the compressive strength, flexural strength, split tensile strength and modulus of elasticity.

6.2 RESULTS AND DISCUSSION

The investigation results for various standard tests on concrete specimen i.e., Compressive Strength, Flexural Strength, Split Tensile Strength and Modulus of Elasticity are compared with Controlled concrete as mentioned below:

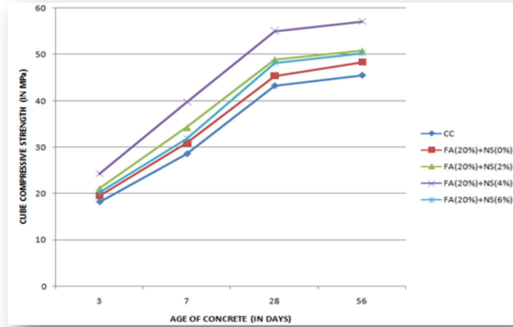
6.2.1 COMPRESSIVE STRENGTH

By the combined application of Fly Ash and Nano-Silica the compressive strength of cube specimens varies with Age of concrete in days as shown in fig-6 and the strength attained is the average of three test results.

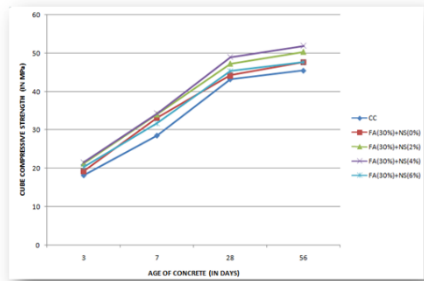
It is noticed that the compressive strength attained by the combined application exhibits more than that of Controlled concrete as shown in table 7

Table 9: Cube Compressive Strengths of M35 Grade Concrete

Concrete Mix	Fly Ash (%)	Colloidal Nano Silica (%)	Compressive Strength (MPa)			
			3 Days	7 Days	28 Days	56 Days
Control Concrete	0	0	18.17	28.55	43.25	45.50
FA 20 % + NS 0 %	20	0	19.53	30.90	45.42	48.35
FA 20 % + NS 2.0%	20	2.0	21.03	34.22	48.92	50.78
FA 20 % + NS 4.0%	20	4.0	24.25	39.70	55.13	57.14
FA 20 % + NS 6.0 %	20	6.0	20.26	31.85	48.25	50.30
FA 30% + NS 0 %	30	0	19.22	33.14	44.19	47.66
FA 30 % + NS 2.0 %	30	2.0	21.23	34.02	47.25	50.32
FA 30 % + NS 4.0 %	30	4.0	21.54	34.26	48.94	51.85
FA 30 % + NS 6.0%	30	6.0	20.39	31.72	45.32	47.62



(a) Fly Ash (20%)



(b) Fly Ash (30%)

Fig: 7Shows the variation of Compressive strength (MPa) for M35 Grade Concrete at various proportions of Fly Ash and Nano-Silica at different Age (in Days)

From fig-7 it is noticed that, the cube compressive strength increases upto the combination Fly Ash (20%) and Nano-Silica (4%) at 7 days and 28 days as 39.70MPa and 55.13MPa. It is observed that a sudden decrement in cube compressive strength occur when Nano-Silica content is above 4%. When Fly ash (30%) content is changed and Nano-Silica (4%) then the compressive strength is less than the compressive strength of controlled concrete. The cube compressive strength increases upto 11.22% and 12.10% by the combined application of Fly Ash (20%) and Nano-Silica (4%) as shown in fig-7.

VII. CONCLUSION AND SCOPE OF FUTURE WORK

7.1 CONCLUSION

- From the investigation results i.e., a partial replacement of cement with Fly Ash and Nano-Silica it is studied that various strength properties of concrete mix increases upto 4% application of Nano-Silica content and decreases with further increment.
- It is quite enthusiastic observation that the changes occurred in the strength properties like compressive strength, tensile strength and flexural strength with change in cement proportion.
- Due to the presence of additional binder which is formed by the combination of Fly ash and Nano-Silica with Calcium hydroxide substantially increases the strength properties of concrete.
- Because of additional binder formed in concrete due to the Pozzolanic additives tends to form a paste-aggregate bond which leads to increment in the strength properties of concrete.
- The partial replacement of Fly ash and Nano-Silica tends to give maximum increment in strength properties at Fly ash content 20% and Nano-Silica content 4%.
- But the decrement in the strength properties with increase in Nano-Silica content is due to the formation of poor quality binder.
- Durability properties of concrete with admixtures Flyash and Nano silica, the sorptivity and RCPT(Rapid chloride permeability test) are observed at 20% FA and 4% NS mix values.

7.2 SCOPE OF FUTURE WORK:

The influence of Fly Ash (FA) and Nano-Silica (NS) are investigated on strength properties of concrete and also durability. This study also helps further to investigate the Resistance impact on concrete using Fly Ash (FA) and Nano-Silica (NS).

REFERENCES

1. Belkowitz,J.and Armentrout, D. L. (2009). The Investigation of Nano Silica in the Cement Hydration Process. ACI Special Publication 267(8): 87-100
2. Thomas et al.,(1999), “Reported that fly ash reduced concrete strength at early ages, but significantly enhanced strength at later ages”. Cement and Concrete Research, Vol 29(4), pp.487-495.
3. Sanchez. F., and Sobolev, K. (2010). “Nano-Technology in Concrete – A Review”, Construction and Building Materials. 24, 2060-2071.
4. GengyingLi.,(2004). “Properties of High-Volume Fly Ash Concrete incorporating Nano-SiO2”, Cement and Concrete Research, pp. 1043-1049.
5. Jagadesh.Sunku (2006),“had studied the advantages of use of fly ash as Supplementary Cementing Materials in Fibre cement sheets. International Inorganic Bonded Fibre Composites Conference, pp.25-32.
6. G.Quercia and H.I.H. Browwers, (2010). ‘Applications of Nano Silica in Concrete Mixtures’, 8th Ph.D. Symposium in Kgs Lyngby, Denmark, June 20-23,

7. C Freeda Christy and D Tensing, (2010). "Effect of Class F Fly Ash as Partial Replacement with cement" IJEMS, Vol 17 pp 140 – 144
8. D.P. Bentz et al,(2010),"studied the evaluation of sustainable high volume fly ash concretes,Cement and Concrete Composites, Vol 33, pp 39-45.
9. G.Carette et.al.(2010)," studied on the early age strength development of concrete incorporating fly ash".Materials, Vol 90(6),pp.535-544.
10. Kazim Turk et.al.(2012)," studied the effect of fly ash and silica fume on Compressive Strength". Construction and Building Materials, Vol 37,pp.326-334.
11. IS: 10262-2009. Concrete Mix Proportioning – Guidelines (First Revision). Bureau of Indian Standards, New Delhi.
12. IS 516:1959. "Methods of Tests for Strength of Concrete". Bureau of Indian Standards, New Delhi, India.
13. IS: 8112:1989. "43 Grade Ordinary Portland Cement – Specifications". Bureau of Indian Standards, New Delhi.
14. IS: 383:1970 (Reaffirmed 1997) Specification for Coarse and Fine Aggregates from Natural Sources for Concrete. Bureau of Indian Standards, New Delhi.