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STUDY OF EFFECTIVE STRENGTH OF CONCRETE USING GGBS AND NANO SILICA

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Abstract- ***Normal conventional concrete has been widely used as a construction material throughout the world because of its advantages of high compressive strength, Durability, workability, mould-ability, etc. The current global scenario shows increased Construction of large and complex structures with heavy reinforcement and complicated shapes. Using normal concrete in such situation may often result in inadequate compaction, affecting performance and long-term durability of structures. One solution for the achievement of durable concrete structures is the use of Self- Compacting Concrete (SCC). At present day Nanotechnology is one of the most active research areas which has wide applications in almost all the fields. So, in these project, Improving Concrete properties by addition of GGBS and Nano-silica, particles and compare the test results with conventional concrete. The Concrete cubes are tested at 7, 14 and 28 days with replacement of 2, 4, 6% of Nano silica & 20% of GGBS to evaluate the compressive Strength and split tensile strength of the concrete and it is concluded that for 4% of Nano silica will give higher compressive and split tensile strength as compare to normal concrete and other percentages of Nano silica***

Key words: *NS=Nano silica, GGBS, OPC Ordinary port land cement, SCC=Self compacting concrete.*

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1. INTRODUCTION

Nano-science is a branch of science that deals with atoms and molecules for production of novel materials, which possess more favourable properties. When a material has at least one component smaller than 100 nm, it can be called a Nano-material. In other words, 'A nanomaterial refers to a solid whose atomic arrangement, size of its crystals, and its chemical composition could be extended in a multi nanometer scale'. Reusing by products such as GGBS, silica fume, and Nano silica is very important in order to achieve sustainability goals in civil engineering.

Performance and efficiency of concrete heavily relies on Nano size constituents such as Calcium Silicate Hydrates (C-S-H) particles. Additives are believed to increase durability and strength of concrete because they consist of fine particles, they have large surface area, and they have a high level of silica. Nano-silica is preferred over other Nano-particles because it has a high capability of improving microstructure of cement-based products. Cement composites with Nano-silica are suitable in order to be used in several applications in which early compressive strength should be taken into account, these applications include concrete roof tiles, masonry blocks, and high strength mortars. They are also important for applications in which flexural strength should be greatly improved, notably in cases where unreinforced cement composites are adopted. Use of even small amount of Nano-silica can improve different properties of cement and concretes and therefore, it can be considered a very important material especially in civil engineering.

2. LITERATURE REVIEW

At present, a significant number of R&D works dealing with the use of NS in cement based materials are available in the literature. However, there is a limited knowledge about the mechanismby which NS affects the flow properties, setting times, consistency, workability, rheological, micro structural, mechanical properties etc. of cementitious mixes. Furthermore, the literature appear to be contradictory about the influence of NS on the development of such materials.

I. Naresh Kumar T, Anusha S, Mahesh M and

Venkata Ramana N (2017): In this the effect of Nano silica and fly ash on compressive strength of cement mortar. The Nano silica (size of particle is 17nano meters) content is varied from 0 to 4% with increment of 1%. The fly ash is also taken mortar and this is taken in to the mix as replacement to the proportion of 0,10,20,30 and 40% in the cement mortar mix along with Nano silica. The cement mortar cubes are tested at 3, 14, 28 and 56 days to evaluate the compressive strength. The results are revealed that, the mix with Nano silica and fly ash is effective at 1% and 20% respectively.

II. Arivalagan.S (2014): had an investigation in the replacement of (GGBS) on ordinary Portland Cement (OPC) OF 20%, 30%, and 40% of GGBS proportions with mix design of M35 at 7 and 28 days. He came to conclusion that strength increases for 20% replacement and also, they proved that GGBS can be used as an alternative material for cement, cost effective as its of industrial waste products.

III. Rishikesh.P et.al (2010): have concluded the replacement of fine aggregate (river sand) by crusher dust up to 50% by weight has a negligible effect on the reduction of any physical and mechanical properties. There was a saving of 56% of money if sand is replaced by crusher dust. It can also reduce the burden of dumping crusher dust on earth and hence environment pollution.

IV. Yogendra.O. patel.et.al (2013): have focused on partial replacement of GGBS varying at 0% to 40% to the weight of OPC of M20 grade for 7,28 and 90 days. The experiment results were observed that the properties can be maintained with GGBS as partial replacement of cement up to 20% that is for 7 days the compressive strength was 10.98N/mm^2 for 28 days it was 20.72 N/mm^2 and for 90 days 23.50 N/mm^2.

V. Dariush Hajizadeh Asl (2016): One of the most important building materials in civil engineering projects is concrete, which is being extensively used all around the world. However, there concerns in the use of concrete in construction attempts regarding its mechanical properties and durability in different settings and environments. Therefore, there has been a great incentive to find out some ways to improve these properties in concretes. One of the most popular ways, at least in theoretical attempts, is the use of Nano-silica in production of concretes. There have been several studies on the application of this agent to improve different properties of concrete. The present study is a review on the use Nano silica in production of concrete in order to improve its mechanical properties and durability.

3. METHODOLOGY & MATERIALS USED

Methodology

- **A.** Collection of materials
- **B.** Basic tests on materials
- **C.** Calculation of mix design as per is 10262,2009
- **D.** Preparation of samples
- **E.** Casting, curing
- **F.** Testing of specimens

Materials used

- **A.** Fine aggregate m sand
- **B.** Coarse aggregate 12.5 mm
- **C.** Cement PPC (53 grade)
- **D.** GGBS & Nano silica type – c powered Nano silica
- **E.** Superplastizer SNF=sulphated naphthalene formaldehyde
- **F.** Equipment's required
  1. Compressive testing machine. (CTM)
  2. Rectangular and cylindrical moulds

I. Tests on materials

TESTS	RESULTS
1.Specific gravity of fine aggregate	**G=2.63**
2. Sieve analysis of fine aggregate	**ZONE -2 AS PER IS 383**
3.Specific gravity of coarse aggregate	**G=2.7**
4.Sieve analysis of coarse aggregate	**12.5 MM**
5. Specific gravity of cement	**G=2.34**
6. Normal consistency test of cement	**32%**
7.Setting time of cement	**30 min**

TABLE 1 : TESTS ON MATERIALS

II. MIX DESIGN AS PER 1S: 10262:2009

1. Target strength for mix proportioning

2. Selection of water cement ratio.

3. Selection of water content.

4. Calculation of cement and GGBS content

5. Proportion of volume of coarse aggregate and fine aggregate content

6. Mix calculation

7. Mix proportion for trial

8. Proportion for m35

Cement: Fine aggregate: Coarse Aggregate

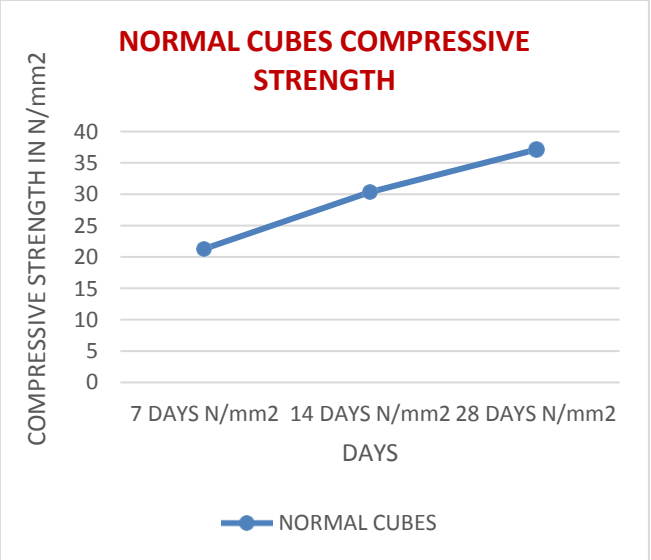
1:1.72:2.72

4. TESTING AND RESULTS

I. Compressive Test Results of Normal Cubes

Sl no	No of days	Test results
1	7 days test in N/mm^2	21.24
2	14 days test in N/mm^2	30.32
3	28 days test in N/mm^2	37.12

TABLE 2: COMPRESSIVE TEST RESULT OF NORMAL CUBE



GRAPH 1: COMPRESSIVE STRENGTH OF NORMAL CUBES

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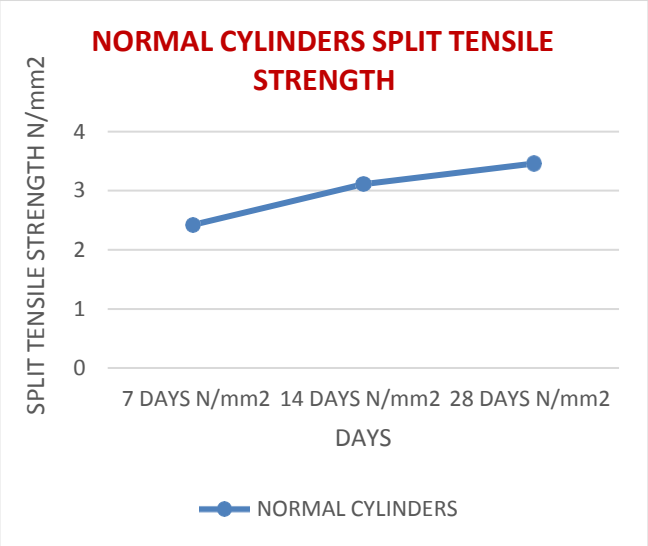
II. Split Tensile Test Results of Normal Cylinders

Sl no	No of days	Test results
1	7 days test in N/mm^2	2.422
2	14 days test in N/mm^2	3.11
3	28 days test in N/mm^2	3.46

TABLE 3: SPLIT TENSILE TEST RESULTS OF NORMAL CYLINDERS

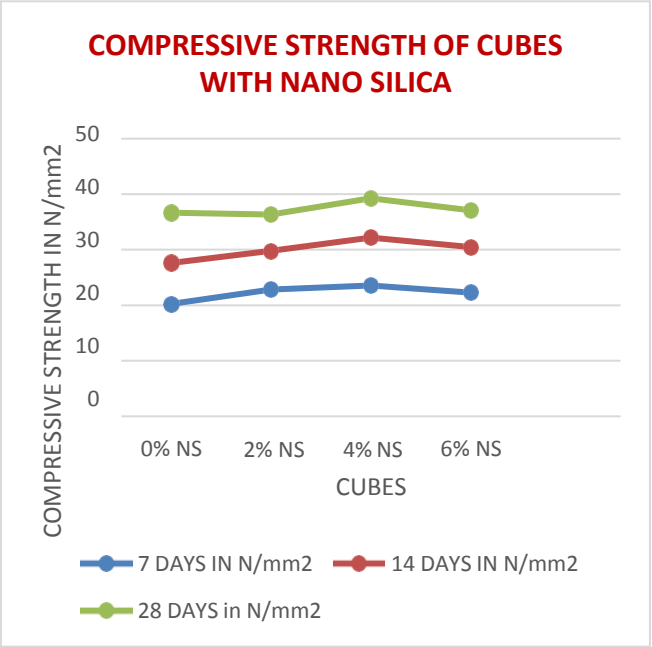


GRAPH 2: SPLIT TENSILE STRENGTH OF NORMAL CYLINDERS

III. compressive strength of cubes with various quantity of Nano silica

Sl no	No of days	0% NS	2% NS	4% NS	6% NS
1	7 days test N/mm^2	20.22	21.79	23.54	22.26
2	14 days test N/mm^2	27.60	29.78	32.17	30.42
3	28 days test	33.67	36.32	39.24	37.1

TABLE 4: COMPRESSIVE TEST RESULT OF CUBE WITH NANO SILICA

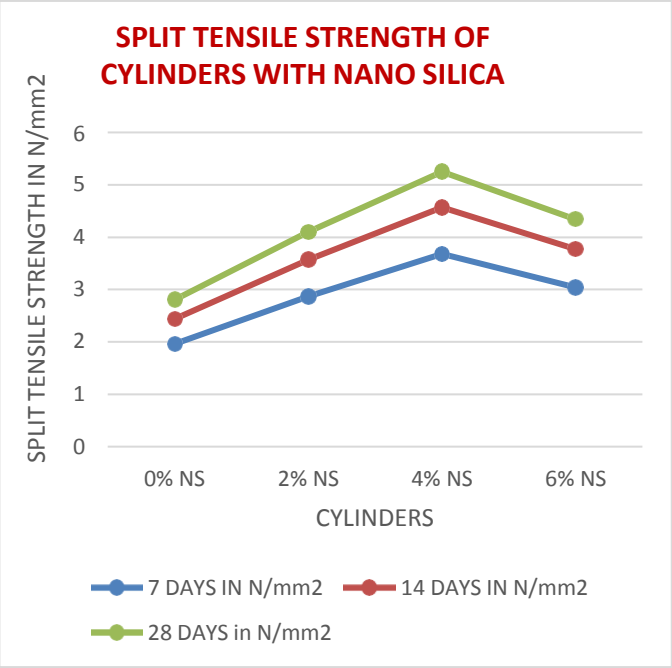


GRAPH 3: COMPRESIVE STRENGTH OF CUBES WITH NANO SILICA

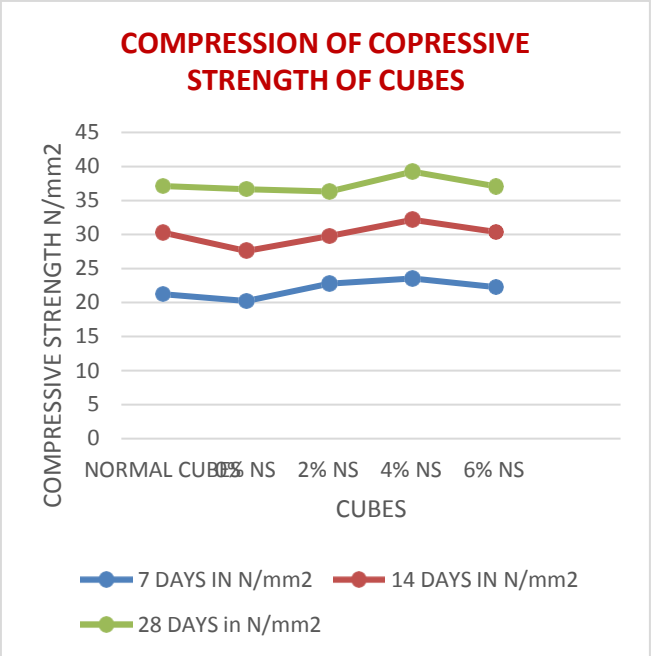
IV. split tensile strength of cylinders with various quantity of Nano silica

Sl no	No of days	0% NS	2% NS	4% NS	6% NS
1	7 days test N/mm^2	1.96	2.871	3.68	3.038
2	14 days test N/mm^2	2.44	3.568	4.57	3.77
3	28 days test N/mm^2	2.806	4.102	5.25	4.341

TABLE 5: SPLIT TENSILE TEST RESULTS OF CYLINDERS WITH NANO SILICA



GRAPH 4: SPLIT TENSILE STRENGTH OF CYINDER WITH NANO SILICA

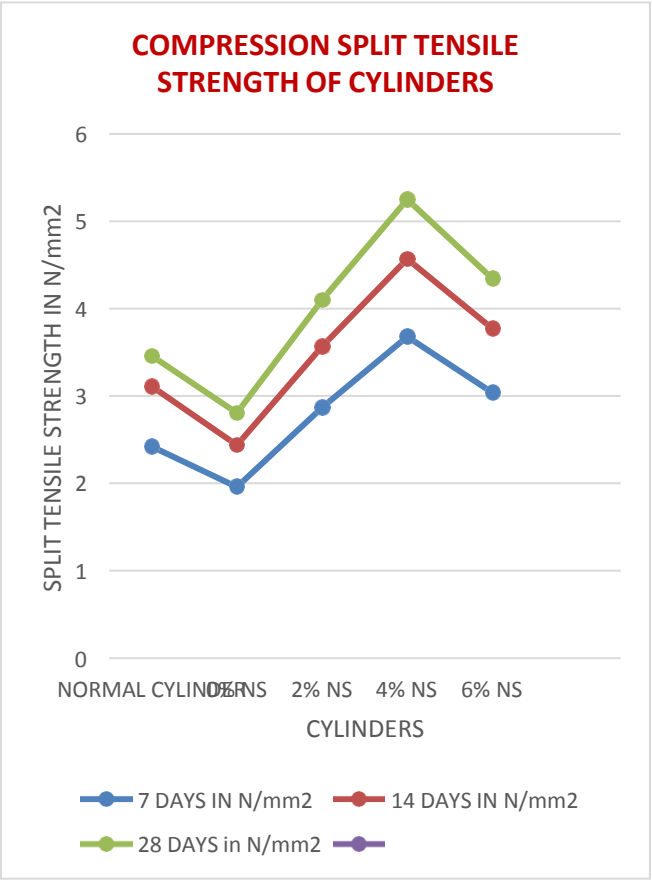


GRAPH 5: COMPRESSIVE STRENGTH VARIATION GRAPH

V. Comparing test results

Sl no	No of days	Normal	0% NS	2% NS	4% NS	6% NS
A	COMPRESIVE TEST					
1	7 days test N/mm²	21.24	20.22	21.79	23.54	22.26
2	14 days test N/mm²	30.32	27.60	29.78	32.17	30.42
3	28 days test N/mm²	37.12	33.67	36.32	39.24	37.1
B	SPLIT TENSILE TEST					
1	7 days test N/mm²	2.422	1.96	2.871	3.68	3.038
2	14 days test N/mm²	3.01	2.44	3.568	4.57	3.77
3	28 days test N/mm²	3.46	2.806	4.102	5.25	4.341

TABLE 6: COMPARING TEST RESULTS



GRAPH 6: SPLIT TENSILE STRENGTH VARIATION GRAPH

5. CONCLUSIONS

From the test results, we can conclude that

1. The result of experimental investigation indicate that the GGBS and Nano silica can be adopted as OPC replacement for concrete preparation

2. The above test result conclude that with increase in % of Nano silica the various strength characteristics of concrete increase ,By using Nano silica and GGBS in preparation of concrete we can reduce cement quantity.

3. The concrete strength upto 4% of Nano silica we can achieve maximum strength of concrete with further increase in the Nano silica the strength characteristics of concrete decrease.

4. Nano silica as high amorphous silica dioxide content the port land cement in the concrete releases calcium hydroxide during hydration process. The Nano silica and GGBS reacts with calcium hydroxide to form additional blinder material. the availability of additional binder leads to increase bond between aggregates results improved strength properties of concrete

5. If we increase Nano silica content beyond 4% the concrete strength will decreases. The decrease in strength of concrete with increase in Nano silica content beyond 4% is due to poor quality of binder formed in the presence of high content of Nano silica and GGBS

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