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STUDY ON WORKABILITY AND COMPRESSIVE STRENGTH OF CONCRETE WITH PARTIAL REPLACEMENT OF NANO SILICA

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Abstract

Cement, sand, and aggregate are primary needs for the construction industry. Sand is a prime material used for the preparation of mortar and concrete and which plays a major role in the mix design. In the world, river sand gets in the natural river. In this project we discuss about different test procedures of cement and aggregates, and to achieve the high strength of concrete adding Nano silica of 1% for M75 grade concrete. The determining strength characteristics of compressive strength and tensile strength by adding 1% rippled steel fibres.

Keyword: Compressive Strength, Nano Silica, Split Tensile Strength, Steel Fibres

1.INTRODUCTION

1.1. Cement- Composition and Hydration

Cement can be described as a crystalline compound of calcium silicates and calcium compounds having hydraulic properties. The four major compounds that constitute cement (bogue's compounds) are tri calcium silicate, di-calcium silicate, tri calcium aluminate, tetra calcium alumino ferrate [1]. Tri calcium silicate and declaim silicate are the major contributors to the strength of cement together constituting about 70% of cement. Anhydrous cement cannot bind for both aggregates. It requires adhesive property which can be achieved by mixing water which is known as hydration of cement.

1.2. Concrete

Generally, concrete contains cement, both aggregates mixed with potable or river water which form hardens with correct time. First type of Portland cement is the mainly used for concrete production. In Concrete technology mainly deals with the study of the concrete properties and also applied in the practical experiments. Mostly concrete is used as columns, slabs, foundations, other construction elements in the construction of buildings. The binding material such as lime, asphalt, mixed with concrete used for construction of road works [2,10].

1.3. Nano Silica

Nano silica or SiO2 nano particles are basics of biomedical research due to their low toxicity, stability and ability with the range of polymers and molecules [5]. According to their structure, it is classified into two types called S and P types. P-type particles are involved by many Nano pores have a pore rate of 0.61 ml/g. The S-type particles have a comparatively smaller surface area [3]. P-type Nano - silica particles are exhibited a more ultra-violet reflectivity when compared to the S-type material. Chemical composition silica is 46.83% and oxygen is 53.33%.

Materials researchers at North Carolina State University have fine-tuned a technique that enables them to apply precisely controlled silica coatings to quantum dot Nanorods in a day-upto 21times faster than previous methods. In addition to the saving time, the quantum dots are less likely to corrupt, preserving their helpful visual properties. The researcher has been used water and ammonia in solution to make possible coating quantum dot Nano rods with silica. The process of

applying the silica coating etches the cadmium sulphide surface of the quantum dot Nano rods, which shortens the length of the Nano rods by as much as four or five Nano meters. That shortening is indicative of etching, which reduces the brightness of the light emitted by the quantum dot Nano rods.

2. MATERIALS AND METHODOLOGY

2.1. Cement

Cement is mixed with water to cause a chemical reaction and then forms a consistency of paste that settled and hardens to form a bind an individual structure of construction materials. It also mixed with water silicates and aluminates, making a water repellent hardened mass that is used for water-proofing [11].

2.2. Coarse Aggregate

The materials that are mostly retained on the 4.75 mm (No. 4) sieve and will pass through 3-inch screen are used.

2.3. Fine Aggregate

The materials are passing the 9.5 mm (3/8 in.) sieve, almost entirely passing the 4.75mm (No. 4) sieve, and mostly retained on the 75 μm (No. 200) sieve are used [6].

2.4. Nano Silica

It can control the degradation of the basic C-S-H (calcium-silicate-hydrate) reaction of concrete caused by calcium leaching in water. The compressive strength of the material is 3 to 6 times the higher when compared to Ordinary Portland Cement (OPC).

2.5. Crimped Steel fibers

The steel fibers are strengthening to concrete by resisting the tensile cracking. That is, it can provide higher resistance to reduce cracks in hardened concrete, also most resistance to withstand heavy loads, moreover static or dynamic as shown in Table 1.

Table 1. Specifications of Crimped Steel fibers

Properties	Specifications as per ASTM A820 M04 Type 1
Length of fibre (l)	5cm
Aspect ratio	30 to 60
Diameter	0.45 to 0.8mm
Appearance	Clear, Bright
Form	undulated along the length
Material type	Low carbon drawn wire

2.6. Water

The water plays an important role in mixing the materials, placing of concrete, compaction, setting and hardening of concrete. The concrete strength has directly depends upon the quantity and quality of water used in the mix proportion.

3. RESULT AND DISCUSSIONS

3.1. Cement

Table 2. Experimental results of cement

S No	EXPERIMENT	RESULTS
1	Specific gravity	3.15
2	Normal consistency	30%
3	Initial and final setting time	Initial- 30min Final- 600min

3.2. Aggregate

Table 3. Experimental results of aggregate

S No	EXPERIMENT	RESULTS
1	Specific gravity of coarse aggregates	2.74
2	Specific gravity of fine aggregates	2.65
3	Sieve analysis of fine aggregate	**Zone 2** (Grading zone)

4	Sieve analysis of coarse aggregate	Graded aggregate is **20mm single size aggregate**
5	Loose density of fine aggregate	4.94 Kgs
6	Bulk density of fine aggregate	5.53 Kgs
7	Loose density of coarse aggregate	13.8 Kgs
8	Bulk density of coarse aggregate	19.39 Kgs
9	Water absorption in coarse aggregate	0.05%

3.3. Nano Silica

Table 4. Experimental results of Nano silica

S No	NANO SILICA	PERCENTAGE OF CONTENTS
1	Liquid content	70%
2	Solid content	30%

Since, grading of fine aggregate has great impact on quality of concrete produced. Therefore, it is necessary to do as per code [6,7] should be followed. By this analysis of N- sand corresponds to grading Zone – 2 which is taken by us.

And the Grading of coarse aggregate greatly influences the cohesiveness of concrete mix. Therefore, it is also necessary to do as per standards. By this analysis of coarse aggregate corresponds to the 20mm single size aggregate.

4. EXPERIMENTAL RESULTS

The tests have done the concrete specimen i.e., cubes according to the designed quantities and the specimens are cured and tested respectively. The obtained slump value for M75 grade concrete is 120mm. These all cubes are cured for 7 days and 28 days respectively and obtained results are tabular below:

4.1. Compressive Strength

4.1.1. 7 days Compressive Strength results (Without Steel fibers) [9]:

Size of the cube = 150 mm × 150 mm × 150 mm

Area of Specimen = 22500 mm2

Table 5. Compressive strength results for 7-days curing of concrete (without steel fibers)

Cube No's	Peak Compressive Load (KN)	Area of Specimen (mm^2)	Compressive Strength of Specimen (N/mm^2)	Avg. Compressive Strength of Specimen (N/mm^2)
1	1212	22500	53.86	64.06
2	1438	22500	63.91	
3	1711	22500	76.04	

The Characteristic Compressive Strength of the cube can be tested with the help of Compression Testing Machine (CTM) in the laboratory.

In general, the cube strength of 7 days must be achieved 65% of Target Mean Strength in which we have achieved approximate values for M75 grade of concrete i.e., (48.75N/mm2). From the above table, we have noticed that the value is more than 65%.

4.1.2. 7-days Compressive Strength results (With Steel fibres):

Table 6. Compressive strength results for 7-days curing of concrete with steel fibres

Cube No's	Peak Compressive Load (KN)	Area of Specimen (mm^2)	Compressive Strength of Specimen (N/mm^2)	Avg. Compressive Strength of Specimen (N/mm^2)
1	1272	22500	56.53	50.56
2	1074	22500	47.73	
3	1067	22500	47.42	

In general, the cube strength of 7 days must be achieved 65% of Target Mean Strength in which we have achieved approximate values for M75 grade of concrete.

As per above graph the average strength for 7 days curing is 50.56 N/mm2.

As Calculations the average strengths for 7 days curing of concrete without steel fibers are better than concrete with steel fibers.

4.1.3. 28 days Accelerated Strength results (Without Steel fibers):

Without steel fibers, the corresponding strength at 28 days can be used as correlation like R28 (Strength at 28 days) = 8.09 + 1.64 Ra

Table 7. Accelerated Strength Values of concrete without steel fibres

Cube No's	Peak Compressive Load (KN)	Area of Specimen (mm^2)	Compressive Strength of Specimen (N/mm^2)	Avg. Compressive Strength of Specimen (N/mm^2)
1	1458	22500	64.80	58.93
2	1320	22500	58.67	
3	1200	22500	53.33	

The value indicates the variations in Compressive Strength without Steel Fibers at 28 days period of time. The Characteristic Compressive Strength of the cube can be tested with the help of Compression Testing Machine (CTM) in the laboratory.

4.1.4. 28 days Accelerated Compressive Strength results (With Steel fibres)

Table 8. Accelerated strength values of concrete with steel fibres:

Cube No's	Peak Compressive Load (KN)	Area of Specimen (mm^2)	Compressive Strength of Specimen (N/mm^2)	Avg. Compressive Strength of Specimen(N/mm^2)
1	1074	22500	47.73	51.71
2	1272	22500	56.53	
3	1145	22500	50.89	

The value indicates the variations in Compressive Strength with Steel Fibres by considering different percentages replacement of River sand at 28 days period of time. The Characteristic Compressive Strength of the cube can be tested with the help of Compression Testing Machine (CTM) in the laboratory.
In general, the cube strength of 28 days must be achieved 100% of Target Mean Strength in which we have achieved maximum values due to the high performance of Admixture.

4.1.5. Comparison of 28-days Accelerated Compressive strength between concrete with steel fibers and without steel fibers (M75):

Tables indicate the variations in Compressive Strength with and without Steel Fibres by considering different percentages replacement of River sand at 28 days period of time.

In general, the cube strength of 28 days can must be achieved 100% of Target Mean Strength in which we have achieved better than target mean strength by and by using high performance Super plasticizer i.e., AURAMIX-500.

4.2. Split Tensile strength

28-days Split Tensile Strength results for different percentages of River sand Replacement with and without steel fibers in concrete

Diameter of the cylinder = 15cm

Height of the cylinder = 30cm

Split Tensile Strength (N/mm2) T = $\frac{2*P}{\pi*L*d}$

Area of cylinder = $177cm^2$

The indicates the variations in Split Tensile Strength with and without Steel Fibers by considering different percentages replacement of River sand at 28 days period of time.

Table 9. Split Tensile strength results of concrete (W&WO steel fibres)

With/Without Steel fibres (W or WO)	Peak Splitting Tensile load (KN)			Average Split Tensile Strength (N/mm^2)
	Cylinder 1	Cylinder 2	Cylinder 3	
W	200	193	204	2.81
WO	223	213	214	3.07

As per above graph the Average split strengths for 28 days curing of concrete without steel fibers is better than concrete with steel fibers.

In general, the cube strength of 28 days can must be achieved 100% of Target Mean Strength in which we have achieved better than target mean strength by using high performance Super plasticizer i.e., AURAMIX-500.

5. CONCLUSION

The conclusions are revealed that the following points such as.

- The addition of steel fibers will increase the self-weight of the concrete. Due to this the Weight of the structure will increases.
- The compressive strength of concrete is increased at natural sand and Nano silica aggregates.
- At the addition of Nano silica, this Nano silica abundant advance in the early age strength of concrete compared to the 28-day increase in strength.
- Also, the addition of steel fibers enhances these tensile strengths of concrete.
- The River sand, Nano silica, and steel fibers combinations achieved better than target mean strength by using Super plasticizer i.e., AURAMIX-500.

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