STRENGTH AND MECHANICAL PROPERTIES OF NANO FLY ASH CONCRETE

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ABSTRACT
Concrete is the universally accepted material to construct the unswerving structures. In order to make high strength, dense, reduction of pores, the lot of research work is going on yet. In that silica has been invented to produce high performance concrete. In this work, the waste which has developed from thermal and power plant industry known as fly ash has been utilized to make the concrete. This fly ash has under gone in ball milling process, for the couple of hour to convert it’s from micro to nano. The output from the ball milling process has confirms its size using SEM Analysis (confirmation of particle size and its distribution). The concrete made with nano fly ash have been under gone the mechanical test properties such as compressive strength test, split tensile test and modulus of rupture for the grade of M20. These test results are compared with conventional, Raw flay ash and Nano silica concrete.

KEYWORDS: concrete, nano fly ash, mechanical properties.

INTRODUCTION
For the decades, in practice the fly ash is used as a partial replacement with cement in concrete. As a by-product of industrial process, utilization of fly ash has made some challenges in sustainable construction. As the presence SiO₂ and Al₂O₃ in the fly ash, during the hydration process, it leads effectively to make denser concrete to produce higher strength and durability. Mechanical properties are important criteria in the concrete structures. Since, the basic requirements of concrete has fulfilled and proven by these properties. The fly ash is the waste material found in thermal and power plant industries enormously. In order to reduce this fly ash dump, lot of research work to be done. Portland Pozzolana cement is the most appreciable invented material to the effective usage of fly ash in cement. In the same way, the fly ash has been added in the form of reduced (Nano) size, to fulfill two requirements such as,
- Pores less concrete to resist adverse environment
- High performance concrete in order to give good durability

J. Babu Rao has done the experiment to made to modify the micro sized fly ash into nano structured fly ash using High Energy Ball, Ball milling was carried out for the total duration of 30 hours and the size has confirmed through SEM analysis and the material composition had found by XRD test. Sri Tudjono has done the tests over the mortar cube, with 2.5% of addition of Nano fly ash and Nano lime with cement to achieve the good compression strength over the mortar cube. Similarly from Prince Arulraj.G, the nano technology gives sufficient improvement in the construction industry to make denser concrete to ascertain good strength and performance over the life span of the structure. From his conclusion, the nano sized particles are most active, the strength of concrete with nano materials was found to be higher than that of Normal Cement Concrete while replacing with nano fly ash to the coarse aggregate.

This paper deals with the concrete made with nano fly ash (Class F) converted from micro to nano by ball milling process, and the concrete made up of nano size fly ash (NFAC) used as admixture and replaced 23% with cement in order to produce the high performance concrete. This 23% replacement has been found by number of trial and error process to achieve its higher strength with the help of compression test on cube. In other hand, the nano silica, has invented to solve the above purpose, but the cost makes this material becomes uneconomical to use at all places. The reduction in particle size gives some want improved strength while comparing with conventional concrete (CC), raw fly ash concrete (RFAC). While sampling the SEM image the nano particles are penetrated and merged with concrete constituents with very less pores on the concrete. It proven that, the material becomes very denser. The above tests were done with the concrete grade of M20.

MATERIALS USED
The following materials were used to make concrete

Cement:
The cement of OPC of grade 53 has used to make the concrete. It has the specific gravity of 3.15 with the fineness modulus value of 0.5%.

Fine aggregate:
In this study, Cauvery river sand has been used as a fine aggregate. It has the specific gravity value of 2.72 with the fineness value of 3.2. It is graded under the Zone III. And it has the value of 22.44% of water absorption.

Coarse Aggregate:
Generally, aggregates occupy 70% to 80% of the volume of concrete and have an important influence on its properties. Furthermore totals use as temperate filler, total for the most part gives concrete better dimensional security and wear resistance. Coarse total adjacent quarry has been utilized for this study. The most extreme ostensible size of the coarse total is kept as 20mm. It has the particular gravity estimation of 2.67 with the devastating and effect estimation of 23.8% and 21%. What's more, it has the estimation of 0.02% of water ingestion.

Fly ash:
Fly ash obtained from Metur Thermal Power station was used in this investigation. This fly ash is classified as class F calcium fly ash. It has the specific gravity value of 2.2.

EXPERIMENTAL PROGRAM
This research paper consisting of the following experimental works are discussed.
1. Mix Design of Concrete
2. Mix outline can be characterized as the procedure of selecting elements of cement and deciding their relative extents with the object of creating cement of certain base quality and strength as financially as could be expected under the circumstances. The blend configuration was done according to IS 10262-2009 rule and last blend extent for M20 evaluation of cement was acquired as 1:2:3

3. Mechanical Properties of Concrete

a) Compressive Strength Test

The solid shape examples were set in pressure testing machine and the load is to be connected without stun and expanded persistently at a rate of roughly 140 kg/cm² per min until the resistance of the example to the expanding load separates and no more noteworthy burden can be limited. The most amazing weight associated with the samples is to be recorded and the nearness of the strong and any unusual components in the sort of failure is noted.

Compressive Strength of the Cube = \( \frac{P}{A} \)

Where,
\( P \) = Maximum applied load to the specimen during the test
\( A \) = The cross sectional area of the cube specimen.

The average value of the three test values is to be taken as the representative of the corresponding mix.

b) Split Tensile Strength Test

The chamber example is set on a level plane between the stacking surface of the pressure testing machine and the load is connected until the failure of the barrel, brought about along the vertical diameter. Slender pressing portions of appropriate materials, for example, plywood are set between the examples and stacking platens of the testing machine the pressing strip is sufficiently delicate to permit circulation of the load over a large contact region. At that point the load is connected until the failure of the chamber, along the vertical measurement.

Split tensile strength = \( 2P/\pi dl \)

Where,
\( P \) = Compressive load on the cylinder
\( l \) = Length of the cylinder
\( d \) = Diameter of the cylinder

c) Flexural Strength Test:

The crystal is placed in all universal testing machine and the load is to be associated without stagger until the case falls level and the best weight associated with the case in the midst of the test is to be recorded. The nearness of the broke faces of the strong and any astounding components in the sort of failure is to be noted. The flexural nature of sample is to be conveyed as the modulus of burst (fb), which is comparable to the division between the lines of the pliable side of the nearer backing, measured on the center line of the tractable side of the case in cm is to be found out to the nearest 0.5 kg/cm² as takes after.

When \( a > 133 \text{ mm} \), \( fb = \frac{PL}{bd^2} \)

When \( a < 133 \text{ mm} \), \( fb = \frac{3Pa}{bd^2} \)

Where,
\( a \) = Distance measured in between crack and nearest support
\( b \) = Width of the specimen in mm
\( d \) = Didth of the specimen in mm
\( L \) = Length in “mm” of the span on which the specimen was supported
\( P \) = Maximum load in “kg” applied to the specimen

If “a” is less than 110 mm for a 100X100X500 mm specimen, the results of the test to be discarded.

Experimental Results & Discussion:

a) Compressive Strength Test

The average compressive strength values after the 28 days curing of the different specimen were listed below.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Types of Concrete (M20 Grade)</th>
<th>Compressive Strength in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CC</td>
<td>25.76</td>
</tr>
<tr>
<td>2</td>
<td>RFAC</td>
<td>27.38</td>
</tr>
<tr>
<td>3</td>
<td>NFAC</td>
<td>34.50</td>
</tr>
</tbody>
</table>

b) Split Tensile Strength Test

The average split tensile strength values after the 28 days curing of the different specimen were listed below.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Types of Concrete (M20 Grade)</th>
<th>Split Tensile Strength in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CC</td>
<td>3.38</td>
</tr>
<tr>
<td>2</td>
<td>RFAC</td>
<td>3.47</td>
</tr>
<tr>
<td>3</td>
<td>NFAC</td>
<td>5.36</td>
</tr>
</tbody>
</table>

c) Flexural Strength Test

The average flexural strength test values after the 28 days curing of the different specimen were listed below.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Types of Concrete (M20 Grade)</th>
<th>Modulus of Rupture in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CC</td>
<td>5.2</td>
</tr>
<tr>
<td>2</td>
<td>RFAC</td>
<td>5.19</td>
</tr>
<tr>
<td>3</td>
<td>NFAC</td>
<td>6.92</td>
</tr>
</tbody>
</table>
The flexural strength of the CC specimen is 5.2 N/mm². The RFAC specimen provides similarity in strength and the NFAC gives 33.07% improved flexural strength over the conventional concrete (CC) specimen.

4. SEM Analysis Report.
The size confirmation and the particle distribution are found from this SEM image report.

CONCLUSION
- Through ball milling process, the size of the fly ash has been converted into Nano size. This size confirmation has kept in Fig. 4.
- The percentage of replacement of the Nano fly ash has the value of 23%. It gives higher strength.
- The compressive strength test result, the NFAC attain the strength of 34.50 N/mm². This is 34% more than the CC Specimen.
- The split tensile strength test result, the NFAC attain the strength of 5.36 N/mm². This is 58.57% more than the CC Specimen.
- The flexural strength test result, the NFAC attain the strength of 6.92 N/mm². This is 33.07% more than the CC Specimen.
- These test results are shown that, the nano fly ash particles are completely fill the pores of the concrete and makes the concrete much denser.

REFERENCES