Effect Of Nano Silica And Silica Fume On The Strength Of Fibre Reinforced Concrete

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Abstract: Nowadays the conventional concrete has lost its usage and it does not serve the present needs. Hence to improve the ultimate strength of the concrete, fibre reinforced concrete (FRC) and pozzolanas are used. Since early 1960’s there has been an increased interest in fibre reinforced concrete (FRC), which means the addition of short discrete fibre in concrete. There are various studies and research that are emerging related to the FRC. This study is mainly concentrated on the mechanical characteristics of FRC with partial replacement of cement by micro silica (5%, 7.5%, 10% and 15%) and nano silica (1.5%, 2%, 2.5% and 3%) for M30 grade of concrete. From the experimental study, the concrete composites with superior properties can be produced using micro silica, nano silica, combination of micro silica and nano silica. This combination in the concrete causes shrinkage and decreases the tensile strength. To overcome this, varying percentages of polypropylene fibre (0.2, 0.4 and 0.6) is added with the optimum 10% of micro and 2.5% of nano silica content. Water cement ratio is constant for all mixtures. The strength test such as compressive, split tensile, flexural strength were investigated.

Key Words: FRC, Micro silica, Nano silica, polypropylene fibre.

I. INTRODUCTION

Cement is the most important material in the construction industry as it is used in different stages of construction in the form of mortar or concrete. The large scale production of cement adds pollution to the environment. Each ton of Portland cement production results in loading about one ton of carbon dioxide into the environment. Therefore it is necessary to find an alternative for cement. Such alternative are micro silica and nano silica, which is a by-product in the production of elemental silica or alloys containing silicon. The main objective of this work is to study the effects of incorporation of micro silica and nano silica in polypropylene fibre reinforced concrete mix as a partial replacement of cement respectively. U. Anil Kumar (2014) made an experimental investigation on the influence of Nano-Silica (NS) on various strength characteristics of concrete containing Micro-Silica (MS). Based on the test results, concrete prepared with a combination of 10% Micro-Silica and 1.5% Nano-Silica possesses improved strength properties compared to the controlled concrete. SudheerJirobe et.al (2015) has suggested that the use of polypropylene fibre increases the mechanical properties of concrete.

II. EXPERIMENTAL PROGRAMME

2.1 Materials used

Ordinary Portland Cement (OPC) of grade 53 conforming to IS: 12269 (1987) were used for the studies. Locally available angular shaped coarse aggregate with a maximum size of 20mm and M sand were used as fine aggregate. The triangular shaped polypropylene fibers of 12mm length which was produced from Cera-Chem Private Ltd., Chennai were used in the present study. Micro silica of diameter 150nm which was collected from Astrra Chemicals, Chennai and nano silica of diameter 17nm which was purchased from Astrra Chemicals, Chennai. The properties of admixture micro silica and nano silica are shown in table 1.

<table>
<thead>
<tr>
<th>Particular</th>
<th>Cement</th>
<th>Micro silica</th>
<th>Nano silica</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific gravity</td>
<td>15</td>
<td>63</td>
<td>3</td>
</tr>
<tr>
<td>Bulk density(Kg/m³)</td>
<td>258</td>
<td>40</td>
<td>4</td>
</tr>
</tbody>
</table>

2.2 Mix design

M30 grades of concrete were designed as per the Indian Standard code of practice 10262-2009. The mix proportion for M30 grades concrete are 1: 1.61: 2.85 with W/C as 0.47.

2.3 Mechanical properties by partial replacement of micro and nano silica

The compressive strength of micro and nano silica is tested at 28 days and the optimum value is chosen and it is found to be 10% and 2.5% respectively. The Compressive strength of micro and nano silica concrete at 28 days are shown in Table2.
Table-2: Compressive strength of concrete at 28 days

<table>
<thead>
<tr>
<th>NO</th>
<th>of micro silica</th>
<th>of nano silica</th>
<th>Compressive strength of concrete (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.5</td>
<td></td>
<td></td>
<td>38.33</td>
</tr>
<tr>
<td>.5</td>
<td></td>
<td></td>
<td>39</td>
</tr>
<tr>
<td>.5</td>
<td></td>
<td>.5</td>
<td>41.22</td>
</tr>
<tr>
<td>.5</td>
<td></td>
<td>0</td>
<td>43.22</td>
</tr>
<tr>
<td>.5</td>
<td></td>
<td>5</td>
<td>40.11</td>
</tr>
</tbody>
</table>

Further the obtained value of micro and nano silica are taken and the specimens were cast to find the mechanical properties of polypropylene fibre reinforced concrete.

III. RESULTS AND DISCUSSION

3.1 Compressive strength test

Compressive strength testing was done on 150 x 150 x 150 mm cubes. The cubes were cast with 10% of micro silica and 2.5% of nano silica with varying percentages of Polypropylene fibre. The cubes were tested in compression testing machine. Total 3 cubes are cast for each trial. The cubes are cured and tested for 28 days. The variation of the compressive strength is shown in chart-1.

3.2 Split tensile strength

The test is carried out with the cylinders of size 150mm x 300mm in height. The specimens are casted with the combination of 10% micro silica and 2.5% nano silica and adding the polyester fibre in the order (0%, 0.2%, 0.4% and 0.6%). Total 3 cylinders are cast for each trial. The cylinders are cured and tested for 28 days. The variation in the strength is shown in chart-2.

3.3 Flexural strength

The beam of size 100mm x 100mm and 500mm in length are cast with the combination of micro silica of 10% and nano silica of 2.5% and also addition of polypropylene fibre at varying percentage of (0%, 0.2%, 0.4% and 0.6%). Total 3 beams are casted for each trial. The beams are cured and tested for 28 day strength. The specimen is subjected to 2 point loading and is tested by flexural testing machine. The variation in strength is shown in chart-3.
IV. CONCLUSIONS
Finally the test results revealed that the following conclusion,

- The concrete specimen incorporated with 10% micro silica and 2.5% nano silica was found to be good in compression which has compressive strength of 12.5% more than that of conventional concrete after 28-days curing period.
- Addition of polyester fibre to the combination increases the compressive, split tensile and flexural strength upto 15.36%, 20.26% and 20.9% respectively.

V. REFERENCES
[8]. K Prathyusha and Dr k Rajasekhar, Strength properties of concrete containing nano silica, metakaolin and quarry dust, International Journal and magazine of Engineering and Technology, 2016, 3(8), pp. 639-644.