Experimental Investigation on Strength Characteristics of Hybrid Fiber Reinforced Self Compacting Concrete

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Abstract

This paper is an attempt to review that study of experimental investigation to find out the optimum mechanical properties of concrete in Self Compacting Concrete (SCC) with mono fiber and hybrid fiber. Due to the use of fly ash, Recron 3s, glass fiber and combination of two fibers, the mechanical properties can be changed. The various combinations of fibers can be taken for testing purpose as range as 0.25-0.75%, 0.5-0.5%, 0.75-0.25% and by volume at a maximum fiber volume fraction of 1%. The main aim of this paper is to identify the effect of filling ability and passing ability of SCC and check SCC with different combination of fibers in same proportion and different proportion. Recron 3s and glass fiber are two fibers used in this research in mono and different combinations.

Keywords: Recron 3s, Passing Ability, Hybrid Fiber, Volume Fraction, Self Compacting Concrete

I. INTRODUCTION

Self-compacting concrete (SCC) is a recently developed concept in which the ingredients of the concrete mix are proportioned in such a way that the concrete is compacted by its self-weight without affecting any vibration and other properties for use of formwork, it is caused by filling a gap in the manner narrow between reinforced bars. Self-compacting is a term which describes a one of the properties of fresh concrete can be satisfied in a numerous ways with various concrete and alternate constituent materials. It is used to facilitate and ensure proper filling and good structural performance of restricted areas and heavily reinforced structural members. Since 1980, SCC was developed in Japan to be mainly used for congested reinforced structures in seismic region. Nowadays SCC has widely used in many construction application for different countries and structural behavior. It reduces the noise and protects the environment being better. The recron 3s and glass is used for increase the mechanical properties of SCC i.e., compressive strength, split tensile, young modulus, flexural strength and durability.

II. MATERIAL USED

A. Cement

Ordinary Portland Cement of 43 Grade conforming to IS: 11269-1987 was used in all mixes. The specific gravity of cement was 3.15

B. Fly Ash

Class F Fly ash was used as secondary cementitious material to replace the cement. The specific gravity of Fly ash was 2.35

C. Fine Aggregate

Locally available river sand passing through 4.75mm IS sieve conforming to grading zone-II of IS: 383-1970 was used. The specific gravity of sand was 2.65
**D. Coarse Aggregate**

Locally available crushed stone metal with a maximum size of 12.5mm IS sieve conforming to grading zone-II of IS: 383-1970 was used. The specific gravity of Coarse aggregate was 2.70

**E. Super plasticizer (SP)**

Glinium sky 8233 super plasticizer was used.

**F. Viscosity Modifying Agent (VMA)**

Glinium stream 2 VMA was used.

**G. Recron 3s fiber**

Recron 3s fiber is a polyester staple fiber used for mixing purpose in the concrete and mortar to improve the properties. Fiber has a shape of triangle because it can be used for anchoring mixing with other ingredients. The fibers are made from terephthalic acid and mono ethylene glycol by polymerizing using catalyst. It is in the length in 6mm, 12mm.

**H. Glass Fiber**

Recron 3s fiber polyester staple fiber for mixing in the concrete and mortar for improving certain properties of concrete and mortar. Good tensile and compressive strength and stiffness, good electrical properties and relatively low cost, but impact resistance relatively poor.

### III. MIX PROPORTION

The experimental investigation was carried out to study the mechanical properties of concrete of M35 grade. The mix proportion was taken by EFNARC Guidance and IS: 10262-2008. Fly ash is used by 15% weight of cementitious material. Two types of fiber are added in this investigation, i.e., recron 3s and glass fiber. Recron 3s and glass fiber were taken in mono and different combinations. The different combinations of fibers 0.25-0.75%, 0.5-0.5%, 0.75-0.25% and by volume at a maximum fiber volume fraction of 1%. Mix proportion is 1:1.6:1

<table>
<thead>
<tr>
<th>Mix</th>
<th>Recron 3s fiber</th>
<th>Glass fiber</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 – SCC with</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>M2 – SCC with</td>
<td>1%</td>
<td>Nil</td>
</tr>
<tr>
<td>M3 – SCC with</td>
<td>Nil</td>
<td>1%</td>
</tr>
<tr>
<td>M4 – SCC with</td>
<td>0.25%</td>
<td>0.75%</td>
</tr>
<tr>
<td>M5 – SCC with</td>
<td>0.50%</td>
<td>0.50%</td>
</tr>
<tr>
<td>M6 – SCC with</td>
<td>0.75%</td>
<td>0.25%</td>
</tr>
</tbody>
</table>

**IV. TESTING ON SCC FRESH PROPERTIES**

**A. Slump Flow Test**

The ability of passing or flowing in horizontal and vertical direction without keeping air entrapped inside the concrete or at the surface is called filling ability. This can be done by slump flow test. The expected value of flow is 650-800mm.

**B. V-Funnel Test**

Segregation resistance is the resistance of the components of SCC to migration or separation. Particles having a relatively high density or a low surface volume ratio are more prone to segregation. This can be done by V-Funnel.
**C. J ring Test**
The ability of passing and filling ability can be done by J Ring Test. It can also be used the resistance of SCC to segregation.

**D. L-Box Test**
Passing ability is required to guarantee a homogenous distribution of the components of SCC in the vicinity of obstacles. The minimum bar distance to avoided blocking depends on the flow ability of SCC, on the maximum aggregates. This can be tested by L-Box.

**V. TESTING ON SCC MECHANICAL PROPERTIES**

**A. Compressive Strength**
The cube specimens were casted in 150mm x 150mm x 150mm. The specimens were remoulded after 24 hours from the casting time and were cured in water for 28 days. Testing was referred by IS: 516-1959. Testing was done under Compressive testing Machine.

**B. Split Tensile Strength**
The cylinder specimens were casted in 150mm x 300mm. The specimens were demoulded after 24 hours from the casting time and were cured in water for 28 days. Testing was done under Compressive testing Machine.

**C. Young Modulus Test**
The cylinder specimens were casted in 150mm x 300mm. The specimens were demoulded after 24 hours from the casting time and were cured in water for 28 days. Testing was done under Compressive testing Machine.

**D. Flexural Strength**
The specimens were casted in 500mm x 100mm x 100mm. The specimens were demoulded after 24 hours from the casting time and were cured in water for 28 days. Testing was done under Universal testing Machine.

**E. Impact Test**
The cylinder specimens were casted in 150mm x 60mm. The specimens were demoulded after 24 hours from the casting time and were cured in water for 28 days. Testing was done under Impact testing machine.

**VI. RESULTS AND DISCUSSION**
The results of fresh concrete tests are shown in Table 2, which included the w/p of the mixture, slump flow diameter, V-funnel flow time, L-Box test and J-Ring test. Also observed in Table 2, the constant water-powder ratio for the same workability measure. The Control SCC mixture had the highest slump flow diameter, but decreased as part of the cement were replaced by fly ash and using steel fibre content. The w/p of for all mixtures the water-powder kept constant, which the steel inclusion reduce the workability, smooth surface characteristics where the fly ash improved the workability characteristics of concrete mixtures, and similar workability properties were achieved by a smaller w/p. Therefore, using a fly ash with higher volumes naturally decreased the water demand of a SCC mixture for similar workability measures. It has been performed for evaluating properties of fresh SCC as given in EFNARC guidelines.

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Slump Flow Test (650 – 800mm)</th>
<th>V-Funnel (8-12 Sec)</th>
<th>V-funnel (+3 sec) T-5</th>
<th>J ring Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>720</td>
<td>9</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>M2</td>
<td>670</td>
<td>10</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>M3</td>
<td>650</td>
<td>11</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>M4</td>
<td>660</td>
<td>11</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>M5</td>
<td>670</td>
<td>11</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>M6</td>
<td>670</td>
<td>10</td>
<td>11</td>
<td>7</td>
</tr>
</tbody>
</table>

**A. Tests on Hardened Concrete**
The results shows that tests were experimented on laboratory at the days of 7 and 28 for testing compressive strength, Split tensile strength, Impact value, flexural strength, Acid attack and sulphate attack tests. In this study, substituting fly ash and steel fibers for improving the strength of SCC.
Table – 4
Test Results on properties

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Compressive strength (N/mm²) 28 days</th>
<th>Split tensile strength (N/mm²) 28 days</th>
<th>Young modulus (N/mm²) 28 days</th>
<th>Flexural strength (N/mm²) 28 days</th>
<th>Impact value (first crack), Failure</th>
<th>% Reduction of Compressive Strength in 5% of Sulphuric acid immersion</th>
<th>% Reduction of Compressive Strength in 5% of MgSO₄ immersion</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>37.40</td>
<td>2.64</td>
<td>21760</td>
<td>3.6</td>
<td>96</td>
<td>101</td>
<td>14.28</td>
</tr>
<tr>
<td>M2</td>
<td>43.30</td>
<td>3.80</td>
<td>30428</td>
<td>4.4</td>
<td>148</td>
<td>156</td>
<td>7.6</td>
</tr>
<tr>
<td>M3</td>
<td>42.30</td>
<td>3.00</td>
<td>26750</td>
<td>3.8</td>
<td>120</td>
<td>128</td>
<td>8.0</td>
</tr>
<tr>
<td>M4</td>
<td>43.00</td>
<td>2.96</td>
<td>25583</td>
<td>3.9</td>
<td>135</td>
<td>142</td>
<td>8.0</td>
</tr>
<tr>
<td>M5</td>
<td>43.50</td>
<td>3.14</td>
<td>28340</td>
<td>4.2</td>
<td>142</td>
<td>149</td>
<td>8.0</td>
</tr>
<tr>
<td>M6</td>
<td>45.60</td>
<td>3.72</td>
<td>30250</td>
<td>4.8</td>
<td>160</td>
<td>165</td>
<td>7.4</td>
</tr>
</tbody>
</table>

VII. CONCLUSION

- Compressive strength of cube for the dosage of M1, M2, M3, M4, M5, M6 at 28 days. Results show that, M6 specimen gives better results compared with other specimen. M6 means combination of fiber (0.75% recron 3s + 0.25% glass fiber).
- Split tensile strength of cube for the dosage of M1, M2, M3, M4, M5, M6 at 28 days. Results show that, M6 specimen gives better results compared with other specimen. M6 means combination of fiber (0.75% recron 3s + 0.25% glass fiber).
- The young modulus of cube for the dosage of M1, M2, M3, M4, M5, M6 at 28 days. Results show that, M2 specimen gives better results compared with other specimen. M2 means 1 of % recron 3s fiber.
- Flexural strength of cube for the dosage of M1, M2, M3, M4, M5, M6 at 28 days. Results show that, M6 specimen gives better results compared with other specimen. M6 means combination of fiber (0.75% recron 3s + 0.25% glass fiber).
- Impact value of cube for the dosage of M1, M2, M3, M4, M5, M6 at 28 days.
- M6 specimen gives better results compared with other specimen. M6 means combination of fiber (0.75% recron 3s + 0.25% glass fiber).
- Durability test result at the age of 28 days. This Results emphasis that M6 specimen shows better result on durability studies

REFERENCES