Studies on Strength Properties of Steel Fiber Reinforced Concrete with Varied Percentage of Fibre Content

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Abstract

Cement concrete is the most extensively used construction material in the world. The reason for its extensive use is that it provides good workability and can be moulded to any shape. Ordinary cement concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks, leading to brittle failure of concrete. In this modern age, civil engineering constructions have their own structural and durability requirements, every structure has its own intended purpose and hence to meet this purpose, modification in traditional cement concrete has become mandatory. It has been found that different type of fibers added in specific percentage to concrete improves the mechanical properties, durability and serviceability of the structure. It is now established that one of the important properties of Steel Fiber Reinforced Concrete (SFRC) is its superior resistance to cracking and crack propagation. In this paper effect of fibers on the strength of concrete for M 35 grade have been studied by varying the percentage of fibers in concrete. Fiber content were varied by 0.25%, 0.50%, 0.75%, and 1%. Cubes of size 150mmX150mmX150mm to check the compressive strength and beams of size 75mmX100mmX500mm for checking flexural strength were casted. All the specimens were cured for the period of 7, 14 and 28 days before crushing. The results of steel fiber reinforced concrete with varied percentage of fiber were studied and it has been found that there is significant strength improvement in steel fiber reinforced concrete. While studying the compressive strength of cube is found for about 0.75% the compressive strength is maximum and 1% for flexural strength of the prisms. Also, it has been observed that with the increase in fiber content value increases the strength of concrete.

Keywords: Cement, Natural Sand, Steel Fibers and Aggregate

I. INTRODUCTION

Fibre reinforced concrete (FRC) is Portland cement concrete reinforced with more or less randomly distributed fibres. In FRC, thousands of small fibres are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties in all directions. FRC is cement- based composite material that has been developed in recent years. It has been successfully used in construction with its excellent flexural-tensile strength, resistance to spitting, impact resistance and excellent permeability and frost resistance. It is an effective way to increase toughness, shock resistance and resistance to plastic shrinkage cracking of the mortar. Fiber is a small piece of reinforcing material possessing certain characteristics properties. They can be circular, triangular or flat in cross-section. The fire is often described by a convenient parameter called —aspect ratio. The aspect ratio of the fiber is the ratio of its length to its diameter. The principle reason for incorporating fibres into a cement matrix is to increase the toughness and tensile strength and improve the cracking deformation characteristics of the resultant composite. For FRC to be a viable construction material, it must be able to compete economically with existing reinforcing system. FRC composite properties, such as crack resistance, reinforcement and increase in toughness are dependent on\ the mechanical properties of the fibre, bonding properties of the fibre and matrix, as well as the quantity and distribution within the matrix of the fibres. the longer fibers.
A. **Advantages of SFRC:**
- Fast and perfect mixable fibers and High performance and crack resistance
- Optimize costs with lower fiber dosages
- Steel fibres reinforced concrete against impact forces, thereby improving the toughness characteristics of hardened concrete.

II. **EXPERIMENTAL INVESTIGATION**

A. **Objectives:**
It is aimed to study the performance of steel fibre reinforced concrete with respect to the strength and durability properties.
Objectives of the experimental investigation are as follows:
- To study the mechanical properties such as compressive strength, flexural strength of concrete at the end of 7, 14 and 28 days of curing period using different proportions of steel fibres. The percentage levels of steel fibres used were 0.25 %, 0.50%, 0.75% and 1.0 %.
- To compare the mechanical properties of steel fibre reinforced concrete with that of conventional concrete.

B. **Materials used:**
The materials used in this experiment were cement, steel fibres, fine aggregate, coarse aggregate and water.

C. **Cement:**
OPC 43 grade cement from a single batch will be used throughout the course of the project work. The properties of cement used are shown in table

D. **Fine Aggregate:**
Locally available river sand belonging to zone II of IS 383-1970 will be using in this project work. The sieve analysis data and physical properties of fine aggregates used are shown in table

E. **Coarse Aggregate:**
Crushed ballast stone of size 12mm and 20mm down conforming to IS 383-1970. Sieve analysis data and physical properties of coarse aggregate of 12mm are shown in table and that of 20mm down are shown in table.

F. **Water:**
Potable water was used in the present investigation for both casting and curing.

G. **Steel Fibre:**
The steel fibres used in this project are according to ISO 9001:2008 Company crambled steel fibres having length(l) 30mm and diameter(d) 0.5mm with aspect ratio(l/d) 60.

H. **Mix Proportion of Concrete:**
Fibres Content in concrete of 0%, .25%, .50%, .75% and 1% were used in the Investigation. Different mix proportion used are shown in table.

<table>
<thead>
<tr>
<th>Components</th>
<th>STEEL FIBRES</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>Water</td>
<td>197</td>
</tr>
<tr>
<td>Cement</td>
<td>438</td>
</tr>
<tr>
<td>SF</td>
<td>0</td>
</tr>
<tr>
<td>Sand</td>
<td>657</td>
</tr>
<tr>
<td>Coarse aggregate</td>
<td>1144</td>
</tr>
<tr>
<td>Density</td>
<td>2450</td>
</tr>
</tbody>
</table>
III. RESULT AND DISCUSSION

A. Compressive Strength

The result of compressive strength test are tabulated in Table 2. From the result it was observed that the compression strength of the concrete increases with increase in the percent of steel fibres. 1%, beyond 1% there was a marginal decrease in the strength of the concrete.

For 7 days curing period, the strength of the concrete is increased about 5.4%, and 8.46% and 10.46% for 0.25%, 0.50% and 0.75% and decreased about 7.53% for 1% of steel fibres respectively when compared with that of conventional concrete.

For 28 days curing period, the strength of the concrete increased about 4.34%, 8.16% and 9.2% for 0.25%, 0.50% and 0.75% and decreases about 4.54% for 1% of steel fibres respectively when compared with that of conventional concrete. At 0.75% of steel fibres the compressive strength of Steel fibre reinforced concrete was found to be more. From the results the optimum percent of steel fibres was found to be 0.75%. The variation of the compressive strength with the age of the curing period and variation of the replacement proportion are shown in Fig 3 and Fig 4 respectively. The failure pattern of cubes is shown in the Fig. 5.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Compressive strength in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 days</td>
</tr>
<tr>
<td>SF 0%</td>
<td>36.8</td>
</tr>
<tr>
<td>SF 0.25%</td>
<td>38.9</td>
</tr>
<tr>
<td>SF 0.50%</td>
<td>40.2</td>
</tr>
<tr>
<td>SF 0.75%</td>
<td>41.1</td>
</tr>
<tr>
<td>SF 1.0%</td>
<td>39.8</td>
</tr>
</tbody>
</table>
IV. FLEXURAL STRENGTH

The results of flexural strength test are tabulated in Table 3. From the result it was observed that the flexural strength of the concrete increases with increase in the content of steel fibres up to 1%, beyond 1% of steel fibres there was a marginal decrease in the strength of the concrete.

For 7 days curing period, the strength of the concrete is increased about 11.36%, 17.02% and 26.41% for 0.25%, 0.50% and 0.75% and decreased about 37.1% for 1% of steel fibre respectively when compared with that of conventional concrete.

For 28 days curing period, the strength of the concrete increased about 8.77%, 13.33% and 21.21% for 0.25%, 0.50% and 0.75% and 30.67% for 1% of steel fibres respectively when compared with that of conventional concrete. At 1% of steel fibres the flexural strength of steel fibre reinforced concrete was found to be more. From the results the optimum percent of steel fibres was found to be 1%. The variation of the compressive strength with the age of the curing period and variation of the replacement proportion are shown in Fig 6 and Fig 7 respectively. The failure pattern of cubes is shown in the Fig.8.

Table 3: Flexural strength of prisms

<table>
<thead>
<tr>
<th>Designation</th>
<th>Flexural strength in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 days</td>
</tr>
<tr>
<td>SF 0%</td>
<td>3.9</td>
</tr>
<tr>
<td>SF 0.25%</td>
<td>4.4</td>
</tr>
<tr>
<td>SF 0.50%</td>
<td>4.7</td>
</tr>
<tr>
<td>SF 0.75%</td>
<td>5.3</td>
</tr>
<tr>
<td>SF 1.0%</td>
<td>6.2</td>
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</table>
V. CONCLUSIONS

The experimental results obtained show that partial substitution of ordinary sand by granular slag gives better results over the verified range from 0 %, .25%, .5%, .75% & 1 % replacement. The conclusions are drawn as below.

1) The addition of fibers in concrete specimens like Cubes and Prisms there is an increase in strength up to some percentage level.
2) The maximum percentage increase in compressive strength at .75% fiber content is was 9.2%. The corresponding increases in flexural and strength value were 21.21 % for 28 days.
3) The flexural strength of the concrete increase up to 1% fibre content is 30.67%.
4) By the addition of fibres crack resistance and ductility of concrete can be increased.

REFERENCES

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