Flexural Properties of Hybrid Fibre Reinforced Concrete - A Comparative Experimental Study

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Abstract

Fiber-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. The most important advantages are hindrance of macro-cracks’ development, delay in micro-cracks’ propagation to macroscopic level. In this project the flexural properties were studied for concrete prepared using different hybrid fibre combinations of glass fibres and polypropylene fibres. The volume fraction of the glass fibres and polypropylene fibres used in this study are 0.4% and 0.5% of total volume of concrete. The flexural properties were studied using centre point loading method on beam specimens. The objective of this study is to evaluate flexural strength of fibre reinforced concrete with respect to different combination of glass fibres and polypropylene fibres. It is observed that quantity of fibres both glass fibres and polypropylene fibres play significant role in increment flexural properties of concrete.

Keywords: Glass Fibre, Polypropylene Fibre, Fresh Properties, Hybrid Fiber Reinforced Concrete (HFRC), Flexural Strength

I. INTRODUCTION

Concrete is a composite material composed of water, coarse granular material (fine & coarse aggregates), embedded in a hard matrix of material (cement) that fills the space among the aggregate particles & glues them together [2]. Concrete, the most ubiquitous material in the world, is a Nano structured multiphase, composite material that age over time [Sanchez and Sobolev, 2010]. It is composed of an amorphous phase, nanometer- to micrometer-size crystals, and bound water. The properties of concrete exist in, and the degradation mechanisms occur across, multiple length scales (Nano to micro to macro) where the properties of each scale derive from those of the next smaller scale.

A. Fibre Reinforced Concrete

A concrete consisting of, cement, water, fine and coarse aggregate, along with different types of Fibres. Fibre reinforced concrete is an alternative way to reinforce concrete other than traditional steel bar. The main purpose of Fibre reinforced concrete it to improve flexural behavior of concrete.

II. MATERIAL AND PROPERTIES

The raw materials used include: tap water, Portland cement, coarse aggregates with diameter of 20mm, fine sand and Perma Plast PC 401 super plasticizer. The cement used in this study is of Binani brand. The grade of cement is 53 and the type of the same is Ordinary Portland Cement. The specific gravity of the cement is 3.15. All properties of cement are tested by referring IS 12269 – 1987. Locally available sand near Surat region is used in this study. Before using in concrete sand is passed from 4.75 mm sieve. Test results of specific gravity and fineness modulus are 2.63 and 2.84 respectively. Course aggregate of size 20 mm available from the source sevalia is used. Specific gravity of coarse aggregate is 2.64 and fineness modulus is 3.79.

The Glass fibres used in this experimental work is of diameter 0.005 to 0.015 mm. Density and tensile strength of the glass fibres are 2.58 g/cm³ and 3445 MPa respectively. Diameter of polypropylene fibre used in this research is 30 to 36 micron. Density and tensile strength of the glass fibres are 0.855 g/cm³ and 670 MPa respectively and specific gravity of the same is 0.91.
Perma Plast PC 401, based on polyearyboxylic Ether hyper plasticising sulphonated synthetic polymers is used in this work as a super plasticizer. It may be dispensed at dosages varying between 0.5 to 2 percent by weight of cement depending upon type of concrete required. Specific gravity of superplasticizer is 1.15.

![Glass fiber and Poly Propylene Fibre](image1)

**Fig. 1: Glass fiber and Poly Propylene Fibre**

### III. MIX DESIGN AND DESIGN OF EXPERIMENTS

All the specimens in this study are cast from M25 grade of concrete. A total of 10 beams of size 700x150x150mm are caste with different combinations of glass fibre and polypropylene fibre including control mix. The main variables in this study are Hybrid fibres with two different types of fibre. Flexural strengths are measured after 28 days of curing period. Details of mix proportions and quantity of each fibres in each mix is shown in table no.

**Table - 1**

<table>
<thead>
<tr>
<th>Materials</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>kg</td>
<td>362</td>
</tr>
<tr>
<td>Fine Aggregates</td>
<td>kg</td>
<td>820</td>
</tr>
<tr>
<td>Coarse Aggregates</td>
<td>kg</td>
<td>1101.71</td>
</tr>
<tr>
<td>Water</td>
<td>lit</td>
<td>152</td>
</tr>
<tr>
<td>Chemical Admixture</td>
<td>kg</td>
<td>4.34</td>
</tr>
</tbody>
</table>

**Table - 2**

<table>
<thead>
<tr>
<th>Mix Name</th>
<th>Glass Fibre</th>
<th>Polypropylene Fibre</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>M2</td>
<td>0.4%</td>
<td>0.4%</td>
</tr>
<tr>
<td>M3</td>
<td>0.4%</td>
<td>0.5%</td>
</tr>
<tr>
<td>M4</td>
<td>0.5%</td>
<td>0.4%</td>
</tr>
<tr>
<td>M5</td>
<td>0.5%</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

![Flexural Strength Test](image2)

**Fig. 2: Flexural Strength Test**
IV. EXPERIMENTAL RESULTS

Flexural strength test is also carried out after the curing period of 28 days. For this centre point loading method is used. The results of the same are as follows,

<table>
<thead>
<tr>
<th>Mix Name</th>
<th>Avg. Flexural Strength (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>3.98</td>
</tr>
<tr>
<td>M2</td>
<td>4.9</td>
</tr>
<tr>
<td>M3</td>
<td>5</td>
</tr>
<tr>
<td>M4</td>
<td>6.425</td>
</tr>
<tr>
<td>M5</td>
<td>6.45</td>
</tr>
</tbody>
</table>

![Graph showing comparison between Avg. Flexural Strength (28 days)](image)

Figure shows that after adding the fibres (Glass & Polypropylene), the flexural strength is increased compared to normal mix and it is maximum at (0.5%, 0.5%) proportion and its value is 6.45 N/mm².

V. CONCLUSION

The workability of fibre reinforced concrete are evaluated using slump test.[6] The results of fresh properties are satisfied according to IS standards.

By adding glass fibres and polypropylene fibres in concrete, values of flexural strength of concrete shows large increment compared to normal concrete. The mix which contains maximum glass fibres as well as polypropylene fibres (M-5) have maximum flexural strength at 28 days curing period. Apart from M-5, M-4 mix which contains higher dosage of glass fibres and lower dosage of polypropylene fibres have higher flexural strength.

From the results we can conclude that flexural strength of concrete is increased with the addition of fibres. Role of fibre is more predominant in case of flexural strength of concrete.

REFERENCES


[5] IRICEN - Indian Railway Institute of Civil Engineering, Pune - “Concrete Technology”


