Experimental Study Based on Strengthening of RC Beam Using Textile Fiber

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ABSTRACT

Textile reinforcement concrete is a new technology of composite material which can even replace reinforcement to some extent. Textile reinforcement is a common method for retrofitting of concrete structures. These textile reinforcement comprises fabric meshes. Jute, glass fibres, Nylons etc are the most commonly used fabric meshes. This project is mainly concerned on the strengthening of concrete structures by providing textile reinforcement. The beam sections used in this research is of size 150 x 250 mm and of 1500mm in length. The beam is designed for 5 ton. When 50KN is applied to the beam, it will fail. After failure the beam is repaired using retrofitting method with basalt textile mesh. Some beams are retrofitted before applying load and a comparison in strength of beam before and after using basalt mesh is studied. Flexural strength was determined and crack pattern studies were carried out. The effectiveness of various profiles of wrapping is studied and maximum deflection and maximum load comparison is made.

Keywords: Textile, Reinforcement, Composite and Beam

1. INTRODUCTION

Textile reinforcement concrete is now being a common method for retrofitting of concrete structures. Textiles comprise fabric meshes made of long woven, knitted or even unwoven fibre rovings in at least two (typically orthogonal) directions. Mortars in which the textile reinforcement is embedded serve as binders containing polymeric additives in order to have improved strength properties. Materials with high tensile strengths with negligible elongation properties are reinforced with woven or unwoven fabrics. The fibres used for making the fabric are of high tenacity like Jute, Glass, Fibre, Kevlar, Polypropylene, Polyamides (Nylon) etc.

Traditionally, bonded steel plates were used as external reinforcement for existing concrete structures. But there are problems associated with them such as the need for careful surface preparation of the steel prior to bonding, uncertainty regarding adhesive bond durability, corrosion at the steel/adhesive interface, the need for anchor bolts, and maintenance painting. As a result of these problems, alternate materials have been sought by engineers. Compared to the strengthening of RC structures with bonded steel plates, the epoxy-bonded fiber composites sheets have many advantages such as high tensile strength, high fatigue strength, light weight, and especially, corrosion resistance. Other advantages offered by fiber composite sheets are that the sheets can be installed at any location on the RC beam to obtain maximum efficiency. The FRP strengthening technique has found wide attractiveness and acceptance among researchers and engineers in many parts of the world, and is no longer considered as a new technique for strengthening jobs. This technique appears to be a suitable way for increasing the strength and stiffness of an existing structure. The merits of this method can be attributed to the availability of reliable and high quality epoxy resins, simple and inexpensive man power requirements, minimum change in geometric dimensions and structural systems, as well as minimum disruption to the structure. The efficiency of this technique can be measured if composite action (i.e. the transfer of stresses from concrete to the external plate) is maintained at all stages of loading, up to failure.

2. METHODOLOGY

Figure 1 shows the Methodology of the study.
3. MATERIAL PROPERTIES

3.1 Cement

Ordinary Portland Cement (53 Grade) was used for casting all the specimens. To produce high-performance concrete, the utilization of high strength cement is necessary. Different types of cement have different water requirements to produce pastes of standard consistency. Different types of cement also will produce concrete have different rates of strength development. The choice of brand and type of cement is the most important to produce a good quality of concrete. The type of cement affects the rate of hydration, so that the strengths at early ages can be considerably influenced by the particular cement used. It is also important to ensure compatibility of the chemical and mineral admixtures with cement. Figure 2 shows the cement.

![Cement Image](image_url)

Figure 2 Cement

Table 1 shows the properties of cement.

Table 1: Properties of Cement
3.2 Properties of Coarse Aggregates
Crushed aggregates of less than 12.5mm size produced by local crushing plants were used. The aggregate exclusively passing through 12.5mm sieve size and retained on 10mm sieve is selected. The aggregates were tested for their physical requirements such as gradation, fineness modulus, specific gravity and bulk density in accordance with IS: 2386-1963. The individual aggregates weremixed to induce the required combined grading. The particular specific gravity and water absorption of the mixture are given in the table 2.

<table>
<thead>
<tr>
<th>PROPERITIES</th>
<th>COARSE AGGREGATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle Shape</td>
<td>Angular</td>
</tr>
<tr>
<td>Particle Size</td>
<td>20 mm</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>2.75</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>1340 kg / m³</td>
</tr>
<tr>
<td>Fineness Modulus</td>
<td>4.18</td>
</tr>
</tbody>
</table>

3.3 Properties of Fine Aggregates
Sand is a natural granular material which is mainly composed of finely divided rocky material and mineral particles. The most common constituent of sand is silica (silicon dioxide, or SiO2), usually in the form of quartz, because of its chemical inertness and considerable hardness, is the most common weathering resistant mineral. Hence, it is used as fine aggregate in concrete. River sand locally available in the market was used in the investigation. The aggregate was tested for its physical requirements such as gradation, fineness modulus, specific gravity in accordance with IS: 2386-1963. The sand was surface dried before use. Table 3 shows the Properties of fine aggregates.

<table>
<thead>
<tr>
<th>PROPERITIES</th>
<th>TEST RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>2.6</td>
</tr>
<tr>
<td>Bulk Density Kg/M³</td>
<td>1830</td>
</tr>
<tr>
<td>Porosity,%</td>
<td>29.67</td>
</tr>
<tr>
<td>Grading Zone</td>
<td>Zone II</td>
</tr>
<tr>
<td>Fineness Modulus</td>
<td>3.13</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>1.02%</td>
</tr>
</tbody>
</table>

3.4 Water
The amount of water in concrete controls many fresh and hardened properties in concrete including workability, compressive strengths, permeability and water tightness, durability and weathering, drying shrinkage and potential for cracking. The ratio of the amount of water, minus the amount of water absorbed by the aggregates, to the amount of cementitious materials by weight in concrete is called the water-cementitious ratio and commonly referred to as the w/cm ratio. The w/cm ratio is a modification of the historical water-cement ratio (w/c ratio) that was used to describe the amount of water, excluding what was absorbed by the aggregates, to the amount of the portland cement by weight in concrete. Figure 3 shows the water.
4. TEXTILE FIBRES

Textile fiber is a material mainly made from natural or synthetic sources. This material will be converted into the making of textile yarns and fabrics; woven, knitted, nonwoven, and carpets. It may be in a form of a pliable hair like strand or as the smallest visible unit of textile production. According to the source from which textile fibres are obtained fibres are broadly classified into two ways. Figure 4 shows the flowchart of the types of fibres.

![Flow chart of the types of fibres](image)

4.1 Mechanical Properties

A textile fibre should have some of the following mechanical properties –

- Strength
- Elasticity
- Extensibility
- Rigidity
- Static Electrification
- Thermal conductivity

4.2 Chemical Properties

A textile fibre should have some of the following chemical properties –

- Action with acid
- Action with alkali
- Action with bleaching
- Action with organic solvent
- Sunlight preventive power
- Mildew preventive power
5. TEST RESULT

5.1 Flexural Strength Test

Table 4 shows the Test result of the flexural strength test.

Table 4: Flexural strength test

<table>
<thead>
<tr>
<th>S.No.</th>
<th>TEST</th>
<th>SPECIMEN</th>
<th>DAYS</th>
<th>LOAD IN (kN)</th>
<th>STRENGTH IN (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CC</td>
<td>TFRC (3 layers)</td>
</tr>
<tr>
<td>1</td>
<td>FLEXURAL</td>
<td>BEAM</td>
<td>7</td>
<td>14.9</td>
<td>16.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14</td>
<td>20.7</td>
<td>22.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28</td>
<td>26.5</td>
<td>27.9</td>
</tr>
</tbody>
</table>

Figure 5 shows the graph of flexural strength test.

![Flexural Strength Test - Bar Chart](image)

**Figure 5** Flexural strength test

Table 5 shows the ultimate load and maximum deflection.

Table 5: Ultimate load and Maximum deflection

<table>
<thead>
<tr>
<th>Specimen</th>
<th>No. of layers</th>
<th>Ultimate load</th>
<th>Maximum deflection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam-1</td>
<td>0 layer</td>
<td>98 kN</td>
<td>10 mm</td>
</tr>
<tr>
<td>Beam-2</td>
<td>1 layer</td>
<td>105 kN</td>
<td>6.1 mm</td>
</tr>
<tr>
<td>Beam-3</td>
<td>2 layers</td>
<td>111 kN</td>
<td>5.8 mm</td>
</tr>
<tr>
<td>Beam-4</td>
<td>3 layers</td>
<td>115 kN</td>
<td>5.0 mm</td>
</tr>
</tbody>
</table>
6. CONCLUSION
Experimental investigations were carried out on the control and textile wrapped beam specimens. Load carrying capacity and maximum deflection were analysed for control and textile fibre wrapped beams and the following conclusions were drawn.

- In the experimental study the control beam and layered textile fiber upgraded beam was tested.
- Also from the study it has been found that when the number of layers of textile fibers increases, the load carrying capacity of the beam increases.
- Similarly, the deflection of the beam also decreases due to the application of fibres.
- The flexural strength of the beam also increased in textile fibre reinforced concrete.
- The experimental values and the analytical values of deflection may slightly vary. This might be caused by the quality of materials, quality of casting, errors occurred during testing.

References


[27] T.Subramani, A.Anbucheian, "Experimental Study Of Palm Oil Fuel Ash As Cement Replacement Of Concrete", International Journal of Application or Innovation in Engineering & Management (IJAEM), Volume 6, Issue 3, March 2017, pp. 001-005, ISSN 2319 - 4847.


[34] T.Subramani, M.Meganathan, S.Priyanka , " Experimental Study On Strength Properties Of Diaphanous Concrete With Vermiculite " , International Journal of Application or Innovation in Engineering & Management (IJAIEG), Volume 6, Issue 5, May 2017 , pp. 229-238 , ISSN 2319 - 4847.


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