Experimental Study on Deflection Behavior of One-Way Slab using GFRP Bars

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Abstract

This paper deals with a state of art research on deflection behavior of one-way slab with replacing FRP bars as a in deflection behavior and cracks in FRP reinforced material. This paper present flexural behavior of one-way slab to its replacement of Steel bars. The use of FRP bars as a reinforcement in concrete structure has increased rapidly last few years due to their highly corrosion resistance. To change in reinforcement ratio in the main reinforcement bars as well as secondary reinforcement bars. Total nos. of eight one-way slabs results are discussed in this paper. Slab dimension is length 1m, width 0.35m and thickness of slab is 0.10m.

Keywords: Deflection; FRP Bars; Concrete; Deformation Behavior; Flexural Stiffening

I. INTRODUCTION

The use of FRP reinforced as reinforcement in concrete structures has rapidly increased in recent years owing to their excellent corrosion resistance, high tensile strength to weight ratio, and good non-magnetization properties. However, concrete members reinforced with FRP bars exhibit large deflection and crack width compared with these reinforced with steel because of FRP low modulus of elasticity. Hence the design of such members is often governed by the serviceability limit states and a general analytical method that can calculate the expected service load deflections of FRP reinforced members with a reasonable degree of accuracy would be very beneficial. As FRP bars possess mechanical properties different from steel bars, including high tensile strength combined with low elastic modulus and elastic brittle stress–strain relationship, the analytical procedure developed for the design of concrete structures reinforced with steel bars is not necessarily applicable to those reinforced with FRP. Fiber reinforced polymer (FRP) composites are currently used as reinforcement for concrete structures where durability or magnetic permeability is the controlling parameter.

Table – 1

<table>
<thead>
<tr>
<th>Material</th>
<th>STEEL</th>
<th>GFRP</th>
<th>CFRP</th>
<th>AFRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>7.9</td>
<td>1.25 to 2.10</td>
<td>1.50 to 1.60</td>
<td>1.25 to 1.40</td>
</tr>
</tbody>
</table>

Table – 2

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STEEL</th>
<th>GFRP (ksi)</th>
<th>CFRP (ksi)</th>
<th>AFRP (ksi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal yield stress, ksi (MPa)</td>
<td>40 to 75 (276 to 517)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Tensile strength, ksi (MPa)</td>
<td>70 to 100 (483 to 690)</td>
<td>70 to 230 (483 to 1600)</td>
<td>87 to 535 (600 to 3690)</td>
<td>250 to 368 (1720 to 2540)</td>
</tr>
<tr>
<td>Elastic modulus, ×103 ksi (GPa)</td>
<td>29.0 (200.0)</td>
<td>5.1 to 7.4 (35.0 to 51.0)</td>
<td>15.9 to 84 (120 to 580)</td>
<td>6.0 to 18. (41.0 to 125.0)</td>
</tr>
<tr>
<td>Rupture strain, %</td>
<td>6.0 to 12.0</td>
<td>1.2 to 3.1</td>
<td>0.5 to 1.7</td>
<td>1.9 to 4.44</td>
</tr>
</tbody>
</table>

II. EXPERIMENTAL METHODOLOGY

A. Details of Test Slabs:
The experimental program consisted of testing eight simply-supported one-way spanning RC slabs. All slabs were prismatic nominally 1000 mm long, 350 mm width and 100 mm deep with clear span (distance between supports) of 850 mm. All the slabs were cast with normal weight concrete with a maximum aggregate size of 15 mm. The concrete had an average compressive...
strength of 25 N/mm² at the time of testing. In slab concrete cover of 15 mm was used for the main reinforcement. Total nos. of eight slabs casted were 2 slabs is purely steel reinforcement and 2 slabs is purely GFRP reinforcement. Other four slabs are composition in the reinforcement as shown in below table.

Table – 3
Details of the Slab and Reinforcement

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Slab specimens</th>
<th>Dimension of Slab (m)</th>
<th>Diameter of Bars</th>
<th>Reinforcement in Slabs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1 &amp; 2</td>
<td>1m×0.35m×0.10m</td>
<td>10mm Ø, 8mm Ø</td>
<td>Steel, Steel</td>
</tr>
<tr>
<td>2.</td>
<td>3 &amp; 4</td>
<td>1m×0.35m×0.10m</td>
<td>10mm Ø, 8mm Ø</td>
<td>Steel, GFRP</td>
</tr>
<tr>
<td>3.</td>
<td>5 &amp; 6</td>
<td>1m×0.35m×0.10m</td>
<td>10mm Ø, 8mm Ø</td>
<td>GFRP, Steel</td>
</tr>
<tr>
<td>4.</td>
<td>7 &amp; 8</td>
<td>1m×0.35m×0.10m</td>
<td>10mm Ø, 8mm Ø</td>
<td>GFRP, GFRP</td>
</tr>
</tbody>
</table>

The slabs were cast on their final supports and the side faces of the form work were removed at an age of one day. Meanwhile, the slabs remained covered with plastic sheet during the first seven days. At an age of 14 days, the bottom of the form work was lowered, subjecting the slabs to their own weight. The flexural behavior of the slabs was further studied by subjecting them to center point loading tests at an age of 28 days. Concrete grade is M25 and Steel grade Fe415 as well as GFRP grade is F70. Design of reinforced concrete slab with steel reinforcement and with GFRP reinforcement has been carried out using Indian Standard and American Standard respectively.

B. Test Results and Discussion:
After the Completion of all test; discussion of all results related above mentioned test should be done in this Phase. This Phase deals with Compression of results in terms of Failure load and deflection included for reinforced concrete slabs with every specimen.

Fig. 1: Graph of 28 Days Concrete Slab with Steel Reinforcement

Fig. 2: Graph of 28 Days Concrete Slab with Composite Reinforcement
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III. CONCLUSION

Experimental results show that the steel reinforced slab was large plastic deformation due to yielding of steel and FRP reinforced slab was non-plastic deformation by brittle fracture by crushing of concrete. All slabs failed with higher amount of failure load as compared to calculated failure load. Reinforced concrete slabs with Steel & GFRP bars have higher deflection as compared to all other slabs specimens. Composite 1 has good strength over all specimens and also having more capacity than design capacity.

REFERENCE

[5] “An Investigation Into The Flexural Behavior Of GFRP Reinforced Concrete Beams”. (Thesis by Douglas Donald Getzlaf, University of...
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