Strengthening of Prefab Slab using Fiber Reinforce Composites

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ABSTRACT
The main objective of using strengthening of pre fab slab by wrapping with frp to to make it more durable during shock as a modification for the prevention of shrinkage cracks. The aim of research is to strengthening of Pre-fab structures slab using glass fiber reinforced composites. Slabs will act as structural members; provide a sensible application for the new material because they can be casted as load bearing and non-load bearing concrete members

Keywords
Glass fiber Reinforced concrete, GFRC, Structural concrete SLAB. Tensile test, Flexural test, Compression test and Load test.

1. INTRODUCTION
In the recent area of civil structure Engineering high profile structures are constructed all over world. According to the day by day demand of society and to satisfy all kind of challenging problem. So the research work in civil structure is all time over worldwide. By looking the past of civil engineering there is lot of mistakes and problems due to the old design codes. Out of the problem the vital problem is strengthening the concrete structures i.e. result of damage & deterioration & serviceability of the structure.

So to reduce the problem & to strength the concrete structure we have a research work on the GFRP sheet laminates on slab. Glass fiber reinforced polymers (GFRPs) is a fiber reinforced polymer made of a plastic matrix reinforced by fine fibers of glass. Fiber glass is a light weight, strong and robust material used in different industries due to the excellent properties. Glass fiber reinforced composite replacing the traditional materials because of its superior properties such as high tensile strength, low thermal expansion, high strength to weight ratio.

In the new strengthening technique GFRP sheets are apply externally bonded reinforcement, on the pre cast slab.

The wrap work is done layer by layer (4 layers & 8 layers). Then we check the result conducting important parameter of testing i.e. flexural, tensile, compressive and load test. The results obtained were compared with only concrete material and 4 and 8 layer of GFRP on the basis of strength and deformation & stress distribution and deflection and cracking point.

2. ABOUT GLASS FIBER REINFORCE (GFRP)
Composite materials produce a combination of two or more materials that cannot be achieved by either Fiber or Matrix when they are acting alone. Fiber reinforced composites were successfully used for many decades for all engineering applications. Example of some vital Fiber is - Glass Fiber, Carbon Fiber, Basalt Fiber etc. Glass Fiber reinforced polymeric matrix comprised organic, polyester, thermostable, vinylester, phenolic and epoxy resins.

The Mechanical behavior of a Fiber- reinforced composite basically depends on the Fiber strength and modules, the chemical stability, matrix strength and the interface bonding between the Fiber/Matrix to enable stress transfer the functional characteristics of suitable composition and desired properties of GFRP composites was equal to steel had higher stiffness than aluminum and specific gravity was one-quarter of the steel. The GFRP Fibers like woven mat, chopped mat have been produced to enhance the mechanical and Tribological properties of the composites.

2.1 Preparation of Glass Fiber composite (woven mat)
GF in composite stronger reinforcement thickness and cross sectional area was different for each specimen. Maximum tensile strength observed in three ply reinforcement, higher VF number of layer of fibers increased the strength and stiffness of the composite.

Fig.1
Fig.2

Table-1 Physical and Mechanical properties of Glass Fiber

<table>
<thead>
<tr>
<th>Fiber</th>
<th>Density (g/cm³)</th>
<th>Tensile strength (GPa)</th>
<th>Young’s modulus (GPa)</th>
<th>Elongation (%)</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-Glass</td>
<td>2.58</td>
<td>3.445</td>
<td>72.3</td>
<td>4.8</td>
<td>17</td>
</tr>
<tr>
<td>C-Glass</td>
<td>2.52</td>
<td>3.310</td>
<td>68.9</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td>S₂ Glass</td>
<td>2.46</td>
<td>4.890</td>
<td>86.9</td>
<td>5.7</td>
<td></td>
</tr>
</tbody>
</table>
2.2 Properties

Faizal MA[1] et al investigated the tensile behavior of plane woven E-GF-reinforced polymer composite with different curing pressure like 35.8 kg/m², 70.1 kg/m², 104 kg/m² and 138.2 kg/m² different lay up like symmetrical and non-symmetrical was used the stress-strength curve showed that the tensile modulus was decreased with increasing curing pressure for both symmetrical and non-symmetrical arrangement in symmetric stiffness decreases in non-symmetric ductility increases.

2.3 Vibration characteristics of GFRP

Colakoglu M.[2] increasfigated the damping and vibration analysis of polyethylene fiber composite under various temperatures ranging from 10⁰ C to 60⁰ C. A damping monitoring method was used to experimentally measure the frequency response and the frequency was obtained numerically using a finite element program. The damping factor determined by the half-power band width.

The experimental result showed that the natural frequency and elastic modulus decreased with increased temperature.

2.4 Environmental behaviors of GFRP

Araujo D[3] investigated the water observation behaviors of fiber glass the water observation decreased with increase of fiber content.

Botelho EC[4] et al investigated the environmental behaviors of woven mat GF-reinforced ply etherified thermoplastics matrix composites. The testing was conducted with varying temperature at relative humidity of 90% for 60 days under sea water. The moisture absorption depends on temperature and relative humidity. Increase with time of 0-18% moisture absorption in 25 days.

L. L am and J.G Yeng[5]  worked on strengthening of RC slab using handed Glass fiber and reinforced plastic (GRFP) strips. The GFRP strips should be anchored to the supporting wall using epsoxy-matrix horizontal slots the prevent of limit debonding.

A report was given by Itaru Nishizaki and Seishi Meiarashi[6] examines the effect of water and moisture on the durability of paltruded glass fiber-reinforced polymers (GFRP) with vinylester resin in normal air conditions.

The local hand mechanics of glass-fiber reinforced polymer (GFRP) bars in normal strength concrete was investigated by S.P. Tastani and S.J. Pantazopou[7] through experimental testing and analytical modeling.

3. STRENGTHENING OR FABRICATION PROCESS

There is a wide variety of techniques by which (GFRP) composite can be fabricated although there are differences between the techniques available for thermo setting and thermoplastic, due to their intrinsic different properties. There are many processes but contact molding by hand lay-up or spray-up is best way to fabricate.

The properties of the reinforced concrete slab and GFRP sheet are different and it depends upon the number of factors including:

- The relative preparations of fiber and matrix.
- The mechanical preparations of constituent materials (fiber matrix and any additives)
- The method of manufacture.

The young’s modulus and tensile strength of composites are lower than that of fibers alone. The volume fraction of fibers normally ranges between 50-66% thus each FRP composite has its own typical mechanical characteristics which make it suitable for a given structural application.

<table>
<thead>
<tr>
<th>Fiber</th>
<th>Density g/cm³</th>
<th>Tensile strength GPa</th>
<th>Poisson’s ratio</th>
<th>Coefficient of thermal expansion (10⁻⁵°C)</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-Glass</td>
<td>2.58</td>
<td>3.445</td>
<td>0.2</td>
<td>54</td>
<td>17</td>
</tr>
<tr>
<td>Normal Slab</td>
<td>2.24-24.0</td>
<td>2.5</td>
<td>0.20</td>
<td>10⁻⁵°C</td>
<td></td>
</tr>
</tbody>
</table>

4. EXPERIMENTAL INVESTIGATION

To check the difference of strength and defection 3 specimen of different layer of slab must taken. One is normal slab then goes through test like flexural and compression test.
4.2 Flexural test

Fig.6

The Flexural test specimens are prepared as per the ASTM D 790 standard. The 3-point flexure test is the most common flexural test for composite materials. Deflection must be measured by the crushed position. Flexural test conducted in universal testing machine and applying force to it until it fractures and break. Test carried out at a relative humidity of 50%.

4.3. Compression Test

Fig.7

The compression specimen is prepared as per the ASTM D6 38 standard. The compression process involves placing the specimen in testing machine and applying compress to it until it fractures. The compress force is recorded as functional of displacement.

4.4 Result and Discussion

The flexural load = \( \frac{pi}{8d^4} \)

The sample graph of flexural strength observed for the GFRP fiber material the result indicate that the maximum applied load up to around 500 N, after that it tends to decrease.

4.4 Compression load - \( \frac{Load}{Area} \)

The specimen sample graph generated directly from machine for compression test with respect to load and displacement for GFRP fiber the graph shows that the maximum load is 28.180 KN the respective displacement is 2.3 mm.

5. CONCLUSION

In the experimental investigation the flexural behavior and compressional behavior of concrete slab strengthened by GFRP sheets are studied. The slab her tested and casted with GFRP and without GFRP with different layers from the test results and calculated strength values, the following conclusion are drawn

1. Initial flexural cracks appear at higher load by strengthening the beam with 4 layers the ultimate load carrying capacity of the strengthen slab is 15% more than the normal slab.
2. Load at initial cracks is further increased by strengthening the slab with 8 layers. The ultimate load carrying capacity of the strengthening beam is 25-30% more than normal slab and 20% more than the 4 layer slab.

Therefore the load carrying capacity is increase with increase of layer of wrapping GFRP on slab.

6. REFERENCES