An Attempt to Develop Belts using Carbon Fibers:-an Experimental Research

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Abstract

Carbon fibers are globally more accepted today because it fulfils many requirements of Today’s world in the field of manufacturing. Growth rate and investments in the field of CFRP products are rapid from last decades. Carbon fiber in the form of CFRP is used in civil engineering for the purpose of seismic retrofitting. Now carbon fiber in the form of high strength woven belts is used in the civil engineering for seismic retrofitting repair and maintenance of walls, beams, and column. The important properties which are tested for the woven carbon belts are tensile strength, seam strength which is important when it is used. The repair and maintenance of the building by this new method is not only cheaper but also last longer and easy.

Keywords: Carbon Fiber, Seismic Retrofitting, CFRP, Reinforced Concrete, Carbon Belt, Aramid Belt

I. INTRODUCTION

Today the world is facing many natural disaster, among all earth quake is the leading one many country faces this problem almost every years; the recent example is Nepal earth quake. The major effect of the earth-quake is on the building which is destroyed or became damaged like crack in the walls, bending or crack in the beam, Colum etc. We know better that reconstruction will be very costly of any type of building which are not fully affected. So the building which is little affected is repaired by newly developed method that is application of CFRP as externally bonded strip. We can also use carbon belts in place of CFRP products because; the carbon belts can be used everywhere like in the repair and maintenance of bridges in the water. Carbon belts are used in the construction and maintenance of already constructed building. Prestressed CFRP for Strengthening of Reinforced Concrete Structures In civil engineering today, only 20 to 30% of the strength of carbon-fiber-reinforced polymer (CFRP) strips is used when they are applied as externally bonded strips for flexural and shear strengthening or in confinement of reinforced concrete (RC) structural elements. The strips are better used when the CFRP material is prestressed. This offers several advantages, including reduced crack widths, reduced deflections, reduced stress in the internal steel, and possibly increased fatigue resistance.

II. WHAT IS CARBON FIBERS?

Carbon fiber is a material which is having fibrous structure as well as micro crystal graphite structure which is manufactured by Acrylic resin fibrillation, acrylic fibers are widely used textile material, the other way is by oil or coal pitch where certain temperature of heat is applied for manufacturing of carbon fibers. Carbon fibers are divided into three category if we see their industrial production namely PAN-based, Rayon based and pitch based. Among three the PAN-based carbon are most frequently produced and is best in used in large volume. From starting of 1970’s the production of carbon fibers of PAN-based was started in Japan at large scale. But after 1979’s the production of carbon fibers of anisotropic pitch based was introduced in the market by some manufacturers because of the improvement of tireless technology business. Japan is still at the top position in the best quality of carbon fibers in the world market today at large scale.

A. Industrial Belts:

The industrial belts are those which are having limited areas of application the carbon belts or carbon composite belts are the examples of the industrial belts which are now started used in the civil engineering fields.
B. Carbon Composite/Carbon Belts Application in Civil Engineering:

The carbon belts prepared can be used in the civil engineering in the repair and maintenance of the damaged walls, column, and beams and at other places also which is very effective.

III. HOW DAMAGED AREA IS REPAIRED

We know that everything are having a certain life after that it starts need of maintenance and repair, in case of any civil construction same things are applied the buildings, bridges or any other construction there is need of maintenance after few years to maintain it for long times, but this is the normal conditions but generally the constructions are affected by natural disasters like earth quake, storm, tsunami, heavy rain or wind. As we all know that any construction need heavy amount of money and mainly the government projects like over bridges, any headquarters etc. If it damaged by any reasons then it not so easy to construct the same in few times and in few money so to avoid these all the damaged areas are repaired to make its life longer. As shown in below fig. the column of the bridge is damaged after long time of construction which is repaired as shown in the figure.

The damaged cracked or deflected area is filled with epoxy a suitable mixture then the Carbon composites strip is wrapped in case of beam or in high tension simple fixed with Column.

IV. Design of Experiment

A. Preparation of Samples:

- Samples are prepared on narrow width Jacob Muller needle machine
- Some parameters for the samples are tried to keep same, weave, but by different count

B. Process of Belts Manufacturing:

Yarn package (carbon) → Small beam preparation → small beam mounting on beam creel → looming in → weaving on tape loom

C. Prepared Samples Specifications:

<table>
<thead>
<tr>
<th>Sample</th>
<th>Warp count</th>
<th>Weft count</th>
<th>EPI</th>
<th>PPI</th>
<th>Weave</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. carbon</td>
<td>6k</td>
<td>6k</td>
<td>8.4</td>
<td>8.4</td>
<td>Plain</td>
</tr>
<tr>
<td>2. carbon</td>
<td>12k</td>
<td>12k</td>
<td>12</td>
<td>12</td>
<td>Plain</td>
</tr>
<tr>
<td>3. carbon</td>
<td>12k</td>
<td>12k</td>
<td>10</td>
<td>10</td>
<td>Twill</td>
</tr>
<tr>
<td>4. Aramid</td>
<td>24k</td>
<td>1800 D</td>
<td>7</td>
<td>7</td>
<td>Twill</td>
</tr>
<tr>
<td>5. Aramid</td>
<td>12k</td>
<td>2000 D</td>
<td>8</td>
<td>8</td>
<td>Twill</td>
</tr>
<tr>
<td>6. Aramid</td>
<td>6300 D</td>
<td>3600 D</td>
<td>20</td>
<td>16</td>
<td>Twill</td>
</tr>
</tbody>
</table>
V. RESULTS AND DISCUSSIONS

Table – 2
Observation Table of All Results

<table>
<thead>
<tr>
<th>Sample With weave</th>
<th>Specification Warp weft/EPI×PPI</th>
<th>Seam cum knob strength In (KN) Over</th>
<th>Tear cum yarn slippage Strength In (KN) over</th>
<th>Tensile strength in (KN)over</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Single thread</td>
<td>10 threads</td>
<td>Warp</td>
</tr>
<tr>
<td>Carbon Plain 1/1</td>
<td>6K×6K/8.4×8.4</td>
<td>0.114</td>
<td>0.247</td>
<td>2.95</td>
</tr>
<tr>
<td>Carbon Plain 1/1</td>
<td>12K×12K/10×10</td>
<td>0.124</td>
<td>0.270</td>
<td>3.00</td>
</tr>
<tr>
<td>Carbon Twill 3/1</td>
<td>12K×12K/12×12</td>
<td>0.100</td>
<td>0.210</td>
<td>3.15</td>
</tr>
<tr>
<td>Aramid Twill 2/2</td>
<td>24K×1800 d/7×7</td>
<td>0.076</td>
<td>0.123</td>
<td>2.85</td>
</tr>
<tr>
<td>Aramid Twill 2/2</td>
<td>12K×2000 d/8×8</td>
<td>0.085</td>
<td>0.140</td>
<td>2.94</td>
</tr>
<tr>
<td>Aramid Twill 2/2</td>
<td>6000 d×3600d/20×16</td>
<td>0.381</td>
<td>0.540</td>
<td>4.50</td>
</tr>
</tbody>
</table>

Fig. 3: Graph 1: Tensile Strength in (KN) Over Warp and Weft

A. From The Tensile Strength Test Results:

We can see the results from the above observation tables and graph the tensile Strength of the carbon belts is high. If the count of the yarn changed. The highest Tensile strength is of sample no 4 which is the Aramid composite yarn but here the Reason for higher tensile strength in warp way is because of 24K carbon warp is Used we can see that in the weft way the same sample no-4 is having least strength Which Shows that aramid yarn is having less tensile strength than carbon .the strength Of Sample 1, 2, 3 and 4 is in the increasing order whereas the sample no 5th and 6th is having less strength this is because of increasing order in count of yarn of carbon Fibers whereas the 5th and 6th samples are having less strength due to decrease in Fibers yarn.
B. Results Seam cum Knob Strength:

Seam cum knob strength is that where we determine that when the belt is fixed in the concrete structure by steel bolt then how much it will have strength to prevent the belts from seam slippage of single and multiple threads. But in case of this application the major role is of epoxy; adhesive used to paste the belts from the wall. From the above observation tables and graph we can see that the seam cum knob strength is in the increasing order slightly for sample no 1 and 2 but in case from the sample no 3 this is sharply rise in the strength .the highest seam cum knob strength is of sample no 6 which is 100 % para aramid. So this because the carbon is having self-lubricating property and slippery in nature make this property poor .the results in case of 10 threads or we can say at the stitching point is almost the same like in case of single yarn strength.

C. Tear Strength:

In case of the industrial belts tear strength is not important properties because i Almost Impossible to tear the belts made of carbon fibers because it is seen than there is just threads Slippage rather than tearing ,and during their use in the civil engineering it does not play any Role from the table and graph us can see that the warp way tear strength in warp way is high for all the samples. 100 % carbon fiber’s belts are having tendency to show higher tear strength than aramid carbon composites. The fluctuations in the results are also higher in case of carbon belts made by 100% carbon fibers in both way warp and weft.
VI. CONCLUSION

The belts samples were prepared from super fibers currently prevailing in the market such as carbon and Para aramid were woven for the experimental work discussed in the thesis. In the light of the data obtained. It can be concluded that the carbon belt samples are having very high performance in all aspect when it is used in civil engineering as external bonded strip .and later on if we compare it with aramid belt sample it is far better in all aspect accept cost.

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