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Original Research Article

OPTIMIZE EFFECT OF TENSILE BEHAVIOUR ON CARBONFIBERS REINFORCED POLYMER MATERIAL

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Abstract: CFRP composites are well suited for turbine blades because of their high strength, high elastic modulus and increased fatigue life. An effort evaluates the advantages offered by tensile load and impact load for the development of composite fiber reinforced polymer material (CFRP).CFRP material is highly efficient in the use of advanced composite materials due to their unique characteristics. These materials can be used as a potential core material for the production. This work presents manufacturing of CFRP composite materials and the effects of tensile load behavior in processing these composite materials.

Key Words:-CFRP, tensile load, fiber reinforced.

Introduction:
Carbon fibers are manufactured by the controlled pyrolysis of organic compound in fibrous form. It is a heat treatment of the organic compound that removes the oxygen, nitrogen and hydrogen to form carbon fibers. It is well established in carbon fiber literature that the mechanical properties of the carbon fibers are improved by increasing the crystallinity and orientation, and by reducing defects in the fiber. The best way to achieve this is to start with a highly oriented organic compound and then maintain the initial high orientation during the process of stabilization and carbonization through tension.

CFRP (Carbon Fiber Reinforced Polymer) is the super hero of the materials world. It is one of the strongest and most light weight materials available on the market today. Carbon fibers a synthetic material that offers a unique combination of qualities, high strength, high stiffness and low weight. Carbon fiber composites are about 3 times stronger and 5 times lighter than steel, and about1.5 times lighter than aluminum. Together with the right binding systems, carbon fiber composites are also known for being extremely corrosion resistant and able to with stand high wear.

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Those qualities make it useful in a wide variety of aesthetic and structural applications. Fiber glass is a lightweight, extremely strong and robust material. Stephen and Thomas [1] studied that the bulk strength and weight properties of glass fiber are favorable properties when compared to metals, and also it is easily moldable. Jiang and Zhang [2] studied that the glass is considered a vitreous super cooled liquid that is in a thermodynamically metastable state between the molten liquid state and the crystalline state. Different glass structures are influenced by the thermal history of the cooling process. At present, five major types of glasses are used to make fibers.

Method

Carbonfiber starts with a precursor polymer material called PAN (Polyacrylonitrile) which is heated until it becomes carbonized. It spun in to extremely fin efibers (thinner than a human hair) which are washed and stretched to obtain the desired fiber diameter. This process also helps align the molecules within the fiber and help secrete tightly bonded carboncrystals. Then, the fibers are heated to 400-600 Fina process that adds oxygen molecules and rearranges the atomic bonding pattern to convert their linear pattern to a more thermally stable add erbonding. After they arestabilized,the fibers are heated to2000–5500 Fin an oxygen free environment to expel on-carbon atoms from the material. The remaining pure carbon atoms for ml on g chain, tightly bonded crystals that are parallel to the long axis of the fiber. This is what gives the fibers their great strength.

Those fibers are collected into thread like bundles called "tows" which are wound on to large bobbins. Standard to wsizes are 1k, 3k, 6k, and12k, but specially products use tows that are 48 k and higher. The k designation means"thousands of filaments per tow". For example, a 3k fabric has 3000 carbonfiber filaments per tow and a 6kh as 6000 filaments per tow.

- Smooth plywood is considered as a work bench for the fabrication of CFRP.
- Carbonfiber cloth is cut into standard dimensions in which carbonfiberis oriented at an angle of 10˚to its longitudinal axis.
- A mixture of epoxyres in, hardener and accelerator is prepared. In1liter fres in, 40 ml of hardener and 30 ml of accelerator is mixed.
- Then carbonfiber cloth is placed over plywood and mixture of epoxyres in, hardener and accelerator is applied over carbonfiber cloth and then carbon fiber cloth in which carbon fiber is oriented at an angle of 10˚ to its longitudinal axis is placed over it and the same mixture is applied again.
- The fourth step is repeated, until thickness of 5 mm is obtained.
- Step four and five are repeated in order to fabricate CFRP in which carbonfibers are oriented at an angle of 10˚to their longitudinal axis respectively.
- Finally, the curing time provided is 24 hours in open atmosphere.

Figure1 Carbon Fiber Cloth

Sample Piece of Tensile Test

CFRP sample piece is obtained according to the standard dimensions i.e. the sample pieces have a total length of 165 mm where gauge length is57 mm and width of 19 mm. Clamping section on either side have length of 45mm. The thickness of the sample piece is 5 mm. The radius of curvature between clamping section and gauge section is 76mm. later the sample piece is given proper finishing.

Figure 2: Sample Piece for Tensile Test
(All dimensions are in mm)

DISCUSSION

Load vs deformation graph is obtained for the respective CFRP sample piece as shown in the figure 3. The load vs deformation graph is used to determine the energy absorbed by the CFRP sample piece for corresponding load and deformation. It also represents the work done by the load on CFRP sample piece to produce the corresponding deformation which is equivalent to area under the curve.

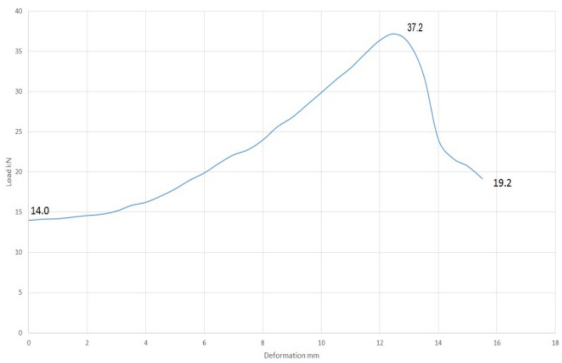

Figure3:Load vs Deformation Graph

Load and deformation values are further used to obtain corresponding stress vs strain graph for the respective CFRP sample piece as shown in figure 4.

$$\sigma = \frac{P}{A}$$

σ = stress developed in the CFRP sample piece, N/mm^2

P=tensile load applied on the CFRP sample piece, *N*

A = area of cross section of the CFRP sample piece =*breadth* × *depth*

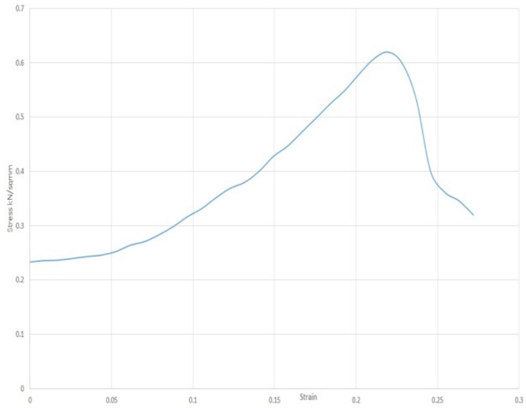

Figure4: Stress vs Strain Graph

Conclusion

Tensile strength of CFRP sample piece in which carbonfiber is oriented at angle of 10˚to its longitudinal axis is found to be maximum, which is followed by CFRP sample piece in which carbon fiber is oriented at angle of 10˚ to its longitudinal axis. In comparisons to GFRP (Glass Fiber Rein forced Polymer), CFRP have more strength. Ultimate tensile strength obtained in case of GFR Pis 22.75MPa whereas in case of CFRP, it is 643.00 MPa. Hence CFRP is 28 times stronger than GFRP.

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