Characterisation Of Cnt Fiber Reinforced Polymer Laminates

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Abstract:

The main aim of this paper is to study the mechanical properties of CNT fiber reinforced polymer laminates. These laminates are known to enhance the mechanical properties. Samples are prepared as per ASTM-D638, ASTM-D790 and ASTM-D785 standards by varying orientations of (0^0,$+45^0$,-45^0) using hand-layup technique. These specimens are tested under tensile and flexural (three point bend test) tests. The results are compared within three different aligned orientations (0^0, $+45^0$,-45^0) for specimens and to evaluate the unknown values of laminates by using Artificial Neural Network using MAT lab software.

Keywords:*CNT (single walled or thin walled), hand-layup technique, cross- ply laminates, ANN.*

1. INTRODUCTION

Application of CNT fiber reinforced polymer laminatesdepends on proper utilization of glass size composition, chemistry, fiber orientation and fiber volume in the matrix for desired mechanical, electrical and thermal properties. Properties of E-glass fiber are low cost, relatively low density, non-flammable, resistant to heat, good chemical resistance and good electrical insulation and high strength and stiffness. Applications of fiber reinforced composites are ships and submarines, aircrafts and spacecraft's, trucks and rail vehicles, automobiles, civil engineering structures[1]. G.Rathnakar et al [2] Performed three point bending tests on specimens of $0/90^0$ and $0/45^0$ by hand lay-up process, composites of glass fiber and graphite fiber reinforced laminates of 2mm and 4mm thickness. The flexural test (3 point bend test) provides a better understanding of the mechanical behavior of the laminated composites. The type of fiber orientation plays a significant role in the determination of the flexural strength. Prashanth Bankeret al [3] Concluded that the experimental investigations used for the analysis of tensile behavior of glass fiber reinforced polymer laminated specimens with lesser thickness leads to more ultimate tensile strength irrespective fiber orientations. Specimen sustain greater load in 90^0orientation specimen than in other orientations.P.Davies et al [4] concluded that Composites are widely used in marineapplications and there is considerable experience of their behavior in service Then a series of tests which have been developed to simulate the loading of marine structures, both for surface vessels and underwater structures will be presented, and examples of failures.Ban Bakir et al [5] investigated that the effect of fiber orientation and fraction volume on mechanical properties for the glass fiber/epoxy. The elastic properties were found for composite laminate hardness test, tensile test were done. For hardness test the values of hardness for the four types of specimen there is no significant effect on hardness of the materials having different orientations of fiber and it is maximum in discontinuous fiber specimen. From the literature no one is worked on through this area. The present paper is worked on evaluation of the mechanical properties of e-glass fiber reinforced cross ply laminates using artificial neural network.

2. EXPERIMENTAL DETAILS.

2.1 MATERIALS AND FABRICATION:

The materials used in the work involved Carbon nanotube (%wt) Resin (LY 556), Hardener (HY 951) and glass fiber (E-glass). Epoxy mixture is the mixture of hardener and resin of total quantity 88% constitutes resin and 10% is hardener and 1% is CNT.The resin transferred along the laminates by applying the external pressure by hand roller and hence the strength increased. Laminates are prepared

by using hand-layup technique. Rolling operation is performed with roller in order to accumulation of resin throughout the fiber material. Same procedure to be followed for different orientation of layers (0^0/+45^0/-45^0).After wet layers are prepared to cure the laminates for 24 hours in room temperature.

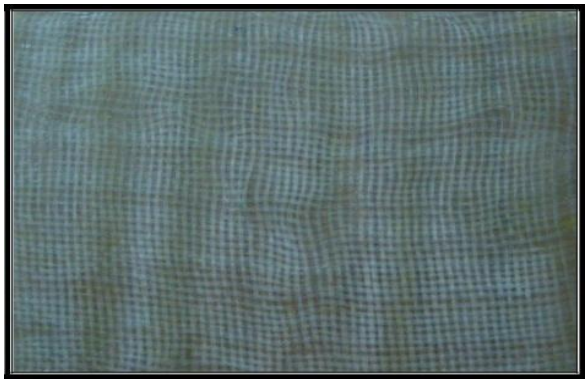

Fig 1.Fabricated laminate

3. MECHANICAL TESTING.

Tensile test samples are prepared according to ASTM D 638 standards. A UTM (universal testing machine) was used for experimentation at CIPET (central institute of plastic engineering and technology) Bhubaneswar(Orissa),India. Data was recorded for each formulation and interpreted on the basis of fiber orientation and fiber volume fraction.

These test samples are prepared according to ASTM-D790 standards. All flexural frames have been designed to accept all the accessories for flexural and transverse tests. Flexural Frames TC4521 model is 100kN capacity. The specimen is deflected until rupture occurs in the outer surface of the test specimen or until a maximum strain of 5.0 % is reached.

4. RESULTS AND DICUSSIONS.

During this hand-layup fabrication technique of the CNT fiber reinforced polymer laminates the tensile strength of composites were compared with three different oriented specimens, from the three different orientations (0^0/90^0/0^0, 0^0/+45^0/0^0, 0^0/-45^0/0^0). From the figure 2 The more tensile strength is for (0^0/90^0/0^0) orientation i.e.126.58MPa compared to other orientations because the fiber is the main loadingelement.

By performing flexural test under ASTM-D 790 test method the allowing results are obtained 150.73MPa,146.44MPa,144.59MPa The flexural strength for (-45^0) orientation is 150.73Mpa. Itis more than (0^0/+45^0/0^0) & (0^0/90^0/0^0) orientation composite laminates. The flexural test (3 point bend test) provides a better understanding of the mechanical behavior of the laminated composites.

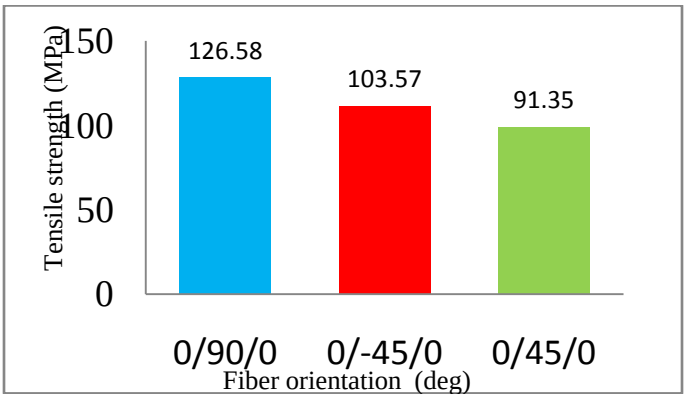

Fig :2 Relation between Tensile stress and fiber orientation of specimens.

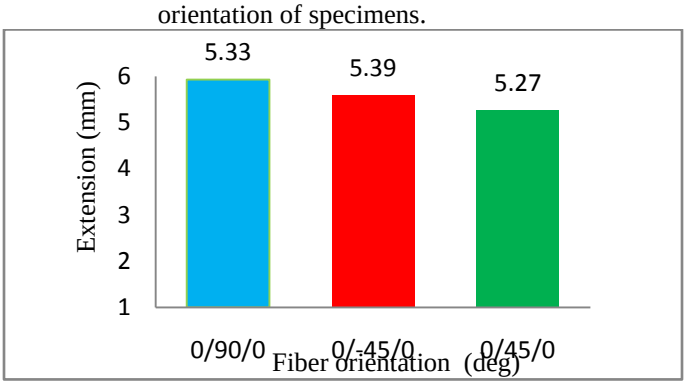

Fig 3: Relation between Extension and fiber orientation of specimens.

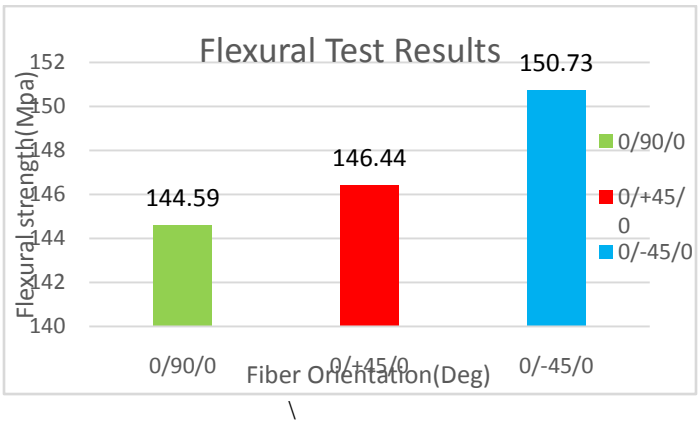

Fig 4: Relation between flexure stress and fiber orientation of specimen

During this hand-layup fabrication technique of this CNT fiber reinforced polymer laminates, the flexural strength of laminates were compared with three different oriented specimens, from the fig 4 three different orientations ($0^0/90^0/0^0$, $0^0/+45^0/0^0$, $0^0/-45^0/0^0$) the more flexural strength is for ($0^0/-45^0/0^0$) i.e.,150.73MPa compared to other orientations because here the fiber is the main loading element.

5. EVALATION OF MECHANICAL PROPERTIES BY USING A.N.N (Artificial Neural Network) using MAT lab software

5.1 RELATION BETWEEN LINEAR AND SPLINE INTERPOLATION:

The graphs which show the predicted values of tensile strength and flexural strength and hardness values and also show the relationship between linear interpolation and spline interpolation.

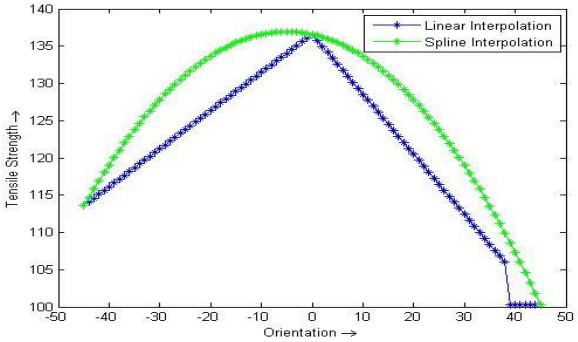

Fig 4: Relation between linear and spline inter polation for tensile strength and orientation of laminate

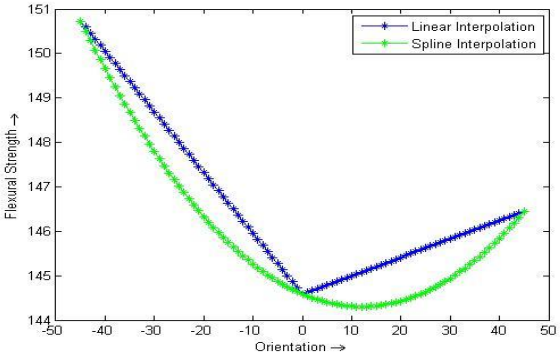

Fig 5: Relation between linear and spline interpolation for flexural strength and orientation of laminate

6. CONCULUSIONS.

The present investigations of mechanical properties of CNT fiber reinforced cross ply laminates reveled that tensile strength and flexural strength are greatly influenced by the orientation of fiber. CNT fiber reinforced polymer laminates were successfully prepared by using hand-layup technique. The model includes the effect of fiber and matrix stiffness, fiber length, fiber orientation and weight composition.The tensile stress maximum are occurring at center of specimen from where fracture starts and in flexural testing maximum stress are occurring at the point where the load is applied and braking starts from that point.

Hence it is a preferred orientation with (0^0) is best suitable for designing of structures in the field of Aerospace, Marine, Automobile because the load carrying capacity is more and also other tensile properties are greater in the CNT fiber reinforced polymer laminates.

These both results in A.N.N (artificial neural network) in linear and spline interpolation are in good arrangement.Using A.N.N. to find out the predicted values of tensile strength and flexural strength values and also shows the relation between linear interpolation and spline interpolation.From above results CNT fiber reinforced polymer laminates are found to be best option for all general application these are having high mechanical properties.

Due to fabrication and experimental constraints we can't fabricate all volumes and orientations of laminateS. It is very difficult to test the specimens. Hence the Artificial Neural Network introduced to evaluate the experiment.

8. REFERENCES

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