Estimation of properties of Composite Material for medical Application

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Abstract- *Metallic implants have been used wide in a very heap of orthopedical applications. Titanium, Ceramics, medical grade titanium and alternative metal alloys are inserted in massive bones designed as artificial joints. Plates and bars are additionally connected to bones so as to facilitate healing of broken bones. The disadvantages of metal implants however ar corrosion and the unharness of ions, so there is want for locating new orthopedical materials like composites, which have a nearer density to the natural bone too. This work is part of the producing and process of carbon fiber or epoxy composite and therefore the assessment of its mechanical properties. Mechanical properties are calculable by ASTM customary strategies. Results are resented according to analysis of composite performance automatically and show the simplest alternative of composite components so as to enhance future use of orthopedical bone plate applications.*

Keywords- Fracture fixation, Hand layup manufacturing process, Orthopaedic bone plate, Mechanical Properties

I. INTRODUCTION

Composite materials had replaced metallic materials in numerous engineering applications in a range of industries as well as transportation, aerospace, pressure vessel and others. One area wherever there has been growing interest for composite materials is medical implants [5]. Some of the benefits of composite materials are their low density, light-weight, high strength to weight ratio. Most of all composite materials are superior to other sorts of materials is their flexibility to be manipulated to realize bound desired properties that can't be achieved by the elementary constituent materials on its own. The properties of composite materials are determined by the properties, ratios, and orientation of constituent parts. The composite martial typically consists of a bonding material known as the matrix, and one or more reinforcing materials known as the fibers [2]. Fixation of long bone fractures with clinically available metal plates could also be restricted due to a twin between the stiffness of the metal plate and therefore the bone. This mismatch may result in “stress shielding”, which leads to a lot of load transfer to the plate rather than the bone, thereby resulting in bone biological process and ultimate implant loosening. Thus, designing a bone plate with mechanical properties shut to animal tissue bone will scale back the negative impact of “stress shielding”[2]. In this regard, composite materials which have mechanical properties close to the bone plate are urged as another to metals for planning bone plate.

II. EXPERIMENTAL METHODOLOGY

A. Materials and Methods

Selection of Material for Preparation of Specimen:

1. Reinforcement Material

- Plain weave Bi- Woven Carbon Fiber

2. Epoxy Resin

- LY556

3. Hardener

- HY 951

The hand lay up process may be a easy methodology that is adopted for the manufacture of the laminated composites, a mould is used for this hand incapacitate process the mould will be as easy as a flat sheet or a flat surface before the basketball shot is completed the surface is totally cleansed by applying some chemical agents like resolvent and to the present surface a unharness agent like wax or oil or mixture is applied to insure the laminated impertinent doesn't adhere to the mould part[8]. The reinforcing material which is plain weave bi-woven carbon fibres are turn over needed size and are set on the flat surface of the mould. The fibres of {the needed|thespecified|the desired} size are set on the required direction as per the planning necessities. The resin that's LY556 and hardener HY 951 ar mixed within the proportions as suggested by the manufacturer within the needed proportions that is within the proportions of 10:1 as urged by the manufacturer is mixed totally and is applied on the laminated surface to be laminated. The organic compound is unfold equally on the reinforcing fibres; the resin is squeezed equally on the surface exploitation a roller and compressed totally with the roller. The reinforcing fibers are stacked one on top of the different and therefore the on top of mentioned procedure is perennial repeatedly. The laminated composites are allowed to cure for twenty four hours. These laminated composites are post cured for temperature of 1200c for a pair of hours to make sure the even distribution of the organic compound and to make sure the right percolation of the matrix into the reinforcing material. The laminate is ready and this laminate is turn over needed size as per ASTM customary and subjected to varied tests.

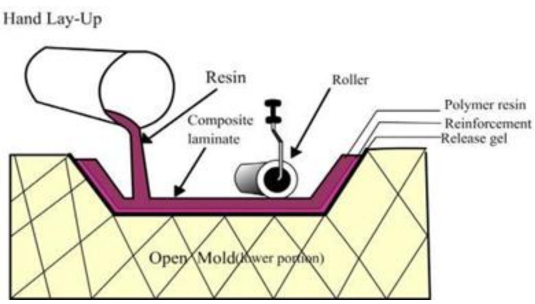

Fig.1 Hand Layup Method [13]

Table.1: Details of Composite Prepared

Sample No.	Composite Material	Fibre Orientation in Deg.	Laminate Thickness in mm
A	Carbon/	0/90°	4
B	Epoxy		5
C	Carbon/	±45°	4
D	Epoxy		5

The composite laminates were subjected to various masses and computer controlled UTM. The specimens were clamped and tested. The tests were conducted at ambient temperature and closely monitored. The load at which the total fracture of the specimen occurred has been accepted as breakage load.

Fig. 2 Tensile Specimen

Fig. 3 bending specimen

Tensile Test

Figure 4 shows the specimen is being mounted on the tension take a look at rig. The tension test is conducted as per ASTM 638 customary. The specimen is loaded step by step the loading was done at a controlled rate, the load at yield point is noted down. additional the specimen was loaded till the specimen fails. The load at yield point was recorded. This is repeated for various specimens.

Fig. 4 Specimen subjected to Tension Test on UTM.

Three Point Bendind Test

The specimens were prepared as recommended by the ASTM D790 standards. The various specimens prepared for the flexural tests which are listed below in the figure. It can be understand that there are carbon fiber reinforced polymer laminates with two different fiber orientations that is 0/900 and ±450, further the laminates are manufactured for two different thickness 4 mm and 5 mm.

Fig. 5 Three point bending test

Barcol Harness Test

The hardness of resins is indication of the level of cure. Hardness increases as cure progresses till a maximum for the resin kind is reached. The Barcol hardness test technique is used to know the hardness of each reinforced and non reinforced rigid composites and to see the degree of cure of resins and composites. The barcol hardness test obtains hardnessvalue.Thisis done by measuring the penetration of a sharp steel point beneath a spring load. Specimens for the Barcol Hardness Test are made and tested according to ASTM D2583.

Fig.6 Hardness Test Fixture

III. RESULT AND DISCUSSION

The characterization of the composites reveals the result of thickness and orientation on the mechanical properties of composites.The properties of composites with completely different thicknesses and orientations are investigated byhardness, tensile andbending test. The result of laminate thickness and orientation on the flexural, hardness and tensile properties of the material is mentioned in table no.2 while graphs are shown for better understanding.

Table 2: Results of tensile test, bending and hardness test

Thickness (mm)	Orientation (0)	Tensile Strength (N/mm^2)	Flexural Strength (N/mm^2)	Hardness
4	0-90	377.49	60.62	51
5	0-90	368.94	240.19	51
4	$\pm 45^0$	46.94	107.85	59
5	$\pm 45^0$	72.59	175.57	56

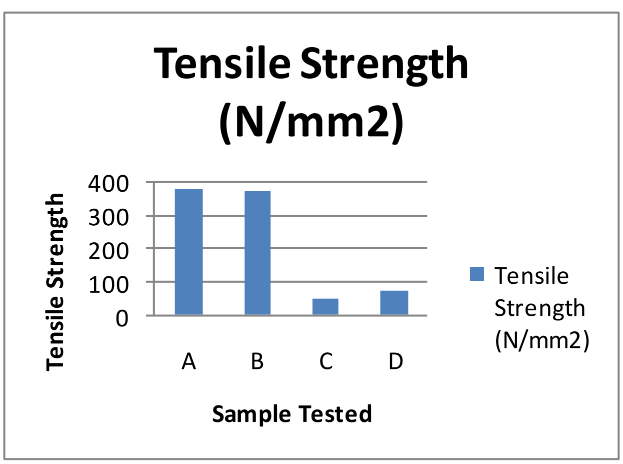

Fig.7 Graphical results of tensile strength

Observations from above results:

- The tensile strength is hold good in case of 90^0orientation.
- In case of 90^0 orientation , more force required for fracture of Carbon fibre reinforced composite.
- In case of $\pm 45^0$orientation tensile strength is lessas compared to 90^0orientation

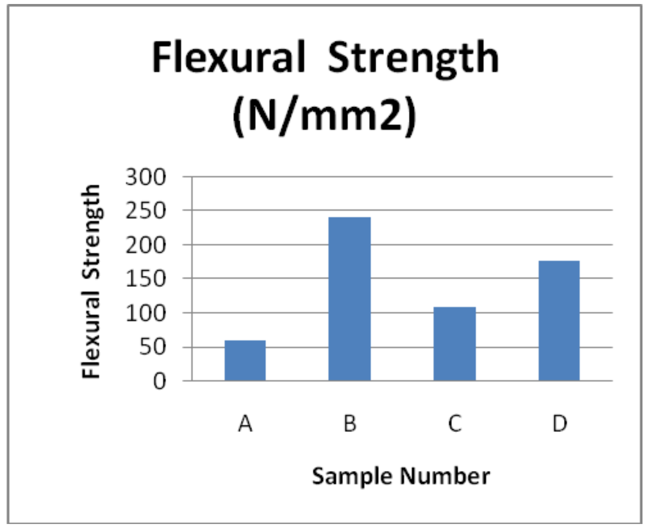

Fig.8. Graphical results of Flexural strength

Observations from above results:

- In case of 90^0fibre orientation.The flexural strength is higher
- In 45^0 orientation More deflection is found. The deflection is less in case of 90^0orientation
- Flexural strength increases with thickness.

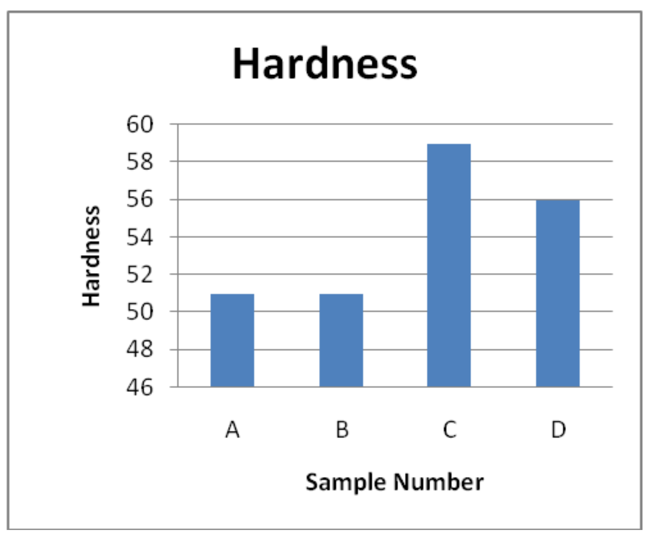

Fig.9. Graphical results of Hardness

Inferences from above results:

- For 45^0orientation,the maximum hardness is found.
- Hardness is not dependent on thickness.

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