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SYNTHESIS OF LAPOX B11 EPOXY BASED NATURAL FIBER COMPOSITES AND COMPARISON WITH ARALDITE EPOXY NATURAL FIBER COMPOSITES

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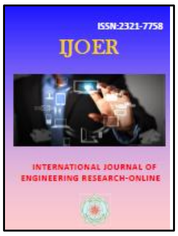


ABSTRACT

Nowadays Natural fiber reinforced composites is an emerging area in polymer science. These Composites are best solutions for the replacement of traditional engineering materials such as metal, ceramic, porcelain and engineering grade thermoplastics. It is because of their high weight to strength ratio, stiffness and other parameters when compared to the others mentioned above . The present research accentuates on the natural fibre reinforced laminar composites using two different types of graded epoxy matrices. The selection of the matrix plays important role in the strength of composites. Laminar composites consists of different layers of fibres which are bonded together by using matrix. Laminar composite materials have their applications in various fields like aerospace, aircraft, automobiles etc. Generally used fibres for the reinforcement are E-glass, S-glass, carbon, aluminium, titanium, steel, graphite etc. but owing to their lack of availability and other environmental factors, these days' natural composites are gathering much attention. So an attempt is made for synthesizing natural fibre composites using different types of graded epoxy resins. There has been a continuous lookout for synthesizing the composites with good mechanical and thermal properties without any compromising. In this work, an attempt has been made in synthesizing natural fibre composites using Lapox B11 epoxy resin and Araldite epoxy resin. Natural fibres selected for the study are jute fibres. Jute fibres are organic, bio-degradable and highly available in nature. They have similar properties to the afore mentioned fibres. The fibres are the load carrying agents so, the orientation of the fibre plays major role in supporting the heavy loads. The woven jute fibre (jute mat) is used as reinforcement for laminar composites. The matrixes used for the study are Lapox B11and Araldite epoxy resins. The resin system used in the research consists of fine fillers and pigments which increased the bonding properties compared to the resins available. The toxicity is generally formed during formation of composites but it is eliminated in our research work. The specimens are made layer by layer for forming laminar composites. The prepared specimens were tested to study the mechanical properties like tensile strength, flexural strength, inter laminar shear strength, impact strength (shock load resistance), compression strength, hardness, elongation at break and the morphological studies give the structural formation at different levels.

Keywords: Araldite, Lapox B11, Jute laminar composites, inter laminar shear strength, impact strength, compression strength, morphology.

I.INTRODUCTION

Composites plays major role in the development of materials today. Composites replaced the metals in most of the applications. It is because of their high weight to strength ratio, stiffness and other parameters when compared to the metals. There has been a continuous lookout for synthesizing the composites with good mechanical and thermal properties. We are more concerned about the natural fibre reinforced composites, they are Eco-friendly and hugely available in nature not get extinct in future. Natural fibres selected for the study are jute fibres. Jute fibres are organic, bio-degradable and highly available in nature. They have similar properties of mineral fibres. In this work, an attempt has been made in synthesizing natural fibre composites using Lapox B11 epoxy resin and Araldite epoxy resin. Lapox B11 is high grade epoxy resin developed by Atul Company, it used as bonding agent and have very good mechanical properties compared Araldite epoxy resin. The fibres are the load carrying agents so, the orientation of the fibre plays major role in supporting the heavy loads. Laminar structure exhibits excellent properties when compared to other alignments. The woven jute fibre (jute mat) is used as reinforcement for laminar composites.

The composites can be prepared with desired properties by orienting the fibres according to the application. The composites are comparatively cheaper to manufacture and there are various manufacturing processes available for the composites. The surface finish of the composite is comparatively much higher and it can be manufactured indifferent techniques. Here in the research the general hand layout method is engaged in the manufacture of the specimens. The use of composites has given more flexibility to design engineers to develop new design and for modifications in the existing design. Since the composites are easier to handle and synthesize. This made scientists and researchers to widen the application of the fibre reinforced polymer composites.

a. matrix selection:

Matrix used is epoxy resin Lapox B11 and the corresponding hardener is the mixture of K41, K42, K49 hardeners, the other epoxy resin is ARALDITE LY-556 and the hardener HY 951(73). The epoxy resins used have excellent mechanical and dynamic strength. Here we are more concerned about the properties of the resin which will further define the properties of the composite. Therefore the selection of the resin (matrix) plays prominent role in defining the properties of matrix. Here Araldite is taken to compare the properties with Lapox B11 epoxy which has better properties than Araldite.

B. fiber selection:

There is a lot of research taking place on the development of fibre reinforced composites to increase its mechanical and physical properties. Composites material with light-weight, high flexural strength & impact strength, good hardness and stiffness properties plays a major role in replacing the metallic and ceramic composites.

The study of natural fibre reinforcement is due its abundant availability in nature .The material scientists all over the world focused their attention on natural composites reinforced with jute, coir, sisal, pineapple, bamboo, banana primarily to reduce the cost of raw materials is to explore its application in different condition. Jute fibres are organic, biodegradable, and largely available in nature. They have similar properties of carbon fibre, glass fibre, etc.

c. orientation:

We are more concerned about the reinforcement i.e. fibres and their orientation. Here we are considering jute fibre which is organic, bio degradable, easily available natural fibre. Strength depends upon the orientation of the fibres, to achieve higher strength the fibres made type which they possess good mechanical properties when it is woven when compared to the individual threads.

In this research fibre reinforced laminar polymer composite is prepared using the specimens are made layer by layer in different combinations with different layers and resins. The prepared specimens were tested to study the mechanical properties like tensile strength, flexural strength, inter laminar shear strength, compression strength, hardness and impact strength.

The commercially available jute threads are woven for preparation of the specimen Here jute fibre is woven for the dimensions of 200mm×200mm which is further used for testing the specimens according to the ASTM standards. The composite is made layer by layer, during the formation of the specimen the initial layer is started by matrix followed by the reinforcement like this up to 3 layers of jute is sandwiched with the matrix and finally matrix is used for finishing the composite. For the study laminates were prepared and sandwiching is as follows Epoxy-jute-epoxy-jute-epoxy-jute-epoxy.

The weight of the woven fibre of dimensions 250×150 mm is 18 grams. The total weight of the reinforcement in each specimen is 54 grams (18*3) for each specimen. The total weight of the Lapox B11 epoxy jute composite is found to be 256 grams and Araldite jute composite is 258 grams. In the Lapox B11 epoxy jute composite for 100grams of matrix the reinforcement of 25.6 grams and nearly same in the polyester jute composite.

II. PROCEDURE

Experimental procedure includes the preparation of specimens. The specimen is synthesized by the hand layout method. One of the matrix used is epoxy resin (ARALDITE LY-556) and the hardener HY 951(73). The other matrix used is Lapox B11 and the hardener is the mixture of K41, K42, K49 hardeners .The woven fibres were added to the resin mixed hardener layer by layer forming laminar composites. The resin hardener mixture was poured in to the moulds for preparation different specimens as per ASTM standards. The curing time taken by the composites was approximately 48hours.The specimen is cured under uniform pressure for equal distribution of matrix. The composite sheets are prepared using glass moulds. The specimens were prepared as sheet using glass moulds. They are Epoxy-jute-epoxy-jute-epoxy-jute-epoxy laminates using two matrixes. In the epoxy jute laminar composite for 100grams of matrix the reinforcement of 25.6 grams is used and same in the polyester jute composite. Tensile test was conducted as per the ASTMD 3039-76. The tensile strength was measured from the universal testing machine. The specimen was held on the machine and tensile force was applied. Tensile stress and tensile modulus was obtained directly. Compressive test is conducted with ASTMD 3410-695 specifications. The flexural test is conducted using specifications of ASTMD 790. The flexural test was carried out using three point bending test in universal testing machine. Stress strain curves are obtained. The impact test is conducted with dimensions of ASTMD 256-88. The tensile, compressive, flexural tests are conducted on Universal Testing Machine. The Charpy impact test is conducted on Izod impact tester. The Charpy impact test was done to determine the resistance of the jute fibre reinforced composite material against shocks. The test is done by breaking the material in one blow by a swinging pendulum. The test piece was notched in the middle at 45° and supported at each end. The energy absorbed was determined in joules and indicates the resistance of the material to shock loads.

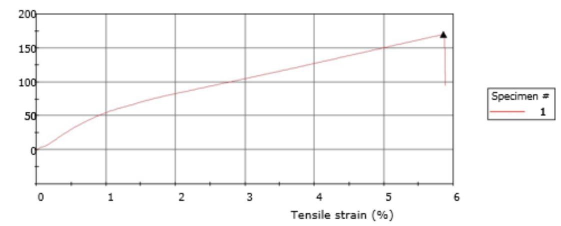
Figure1. lapox B11 composite

III. DISCUSSION OF RESULTS

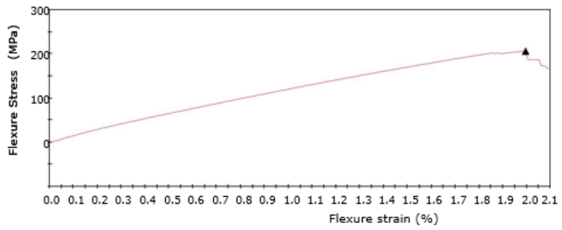
The laminar jute fibre reinforced Lapox B11 and Araldite epoxy composites were subjected to mechanical characterization. The mechanical properties studied are analysed and compared. The results reveal that the Lapox B11 epoxy jute laminar exhibits excellent mechanical properties. The curing time required for Lapox B11 epoxy jute laminar composite is comparatively lesser time than Araldite epoxy jute laminar composite.

TENSILE TEST AND FLEXURAL TEST CURVES FOR LAPOX B11 COMPOSITES

TENSILE TEST CURVE



FLEXURAL TEST CURVE



A. TENSILE TEST:

Tensile test gives the data of ultimate tensile strength and tensile strain at break. These properties indicate the materials behaviour under tensile load. The tensile strength is estimated by using Universal testing machine. The test was conducted according to the ASTM D3039-76 specifications. The temperature and humidity for this test were maintained at 18 ˚C and 50% respectively. Samples are tested and the values are directly obtained from UTM and their mean values are shown in below.

Specimen lable	Maximum Load (N)	Tensile Stress (MPa)	Tensile Modulus (MPa)
Araldite jute laminae	4120.80	136.76	5279.13
Lapox B11 jute laminae	5103.86	170.13	6373.35

Figure2.Tensile test on UTM

Under the load condition the resin plays a major role, it transfers the stresses across the composites. For the composite to perform well under shear loads the resin element must not only exhibit good mechanical properties but must also have high adhesion to the reinforcement fibre. The results in this work confirm that the jute epoxy composite exhibited better tensile strength than the jute polyester composite. The tensile load for a jute laminar composite exhibited better tensile strength than the jute polyester composite. The ultimate strength is found using this information and thus the tensile strength was determined. Generally tensile strength is estimated by using the formula $\sigma t=P/bh$. P= Ultimate load on the specimen, b= Initial width of the specimen(10), h=Initial thickness of the specimen(3). $\sigma t=136.76$ N/mm^2 for Araldite epoxy laminar composite. σt = 170.13 N/mm^2 for Lapox B11 laminate. The Lapox laminar composites tested exhibited excellent properties when compared to the Araldite epoxy jute laminates. The stress strain curve of Lapox laminar composite obtained from UTM is shown along with flexural test.

B. FLEXURAL TEST:

The flexural tests are conducted to determine the mechanical properties of resin and laminated fibre composite materials. Further, these tests are used to determine the interlaminar shear strength of a laminate. The flexural properties of the laminate are determined using the Universal Testing Machine. The three point flexural test was carried out on Universal Testing Machine. The specimens prepared as per the ASTMD 790 standard. The temperature and humidity maintained for this test are 18 ˚C and 50%. The stress-strain curves for jute reinforced laminate composites are obtained from Universal Testing Machine. The flexural strength values are directly obtained from computerized universal testing machine. Flexural strength of the composites are directly obtained from the computerized Universal Testing Machine. The maximum stress obtained for jute epoxy laminate is 83.56 N/mm² and for polyester jute laminate is 46.27 N/mm² The maximum inter laminar shear

S NO	Specimen lable	Maximum Load (kN)	Maximum Stress (MPa)	Flexural Modulus (MPa)
1	Araldite Epoxy Laminate	0.15	83.56	4727.12
2	Lapox B11 Epoxy Laminate	0.37	206.17	13483.79

strength is estimated by using the formula,

σt=3P/4bh

P= Maximum load on the specimen.

b= Initial width of the specimen

h=Initial thickness of the specimen.

The maximum inter laminar shear strength of the epoxy jute laminate is 4.5 N/mm² and polyester jute laminate is 2.1 N/mm².Flexural modulus, maximum load, maximum stress are directly obtained from Computerized Universal testing machine. Stress-strain curves are also directly obtained and maximum inter laminar strength is determined using the above formula.

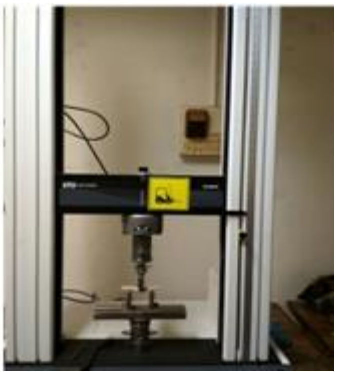


Figure3. Flexural test

C. IMPACT TEST:

Impact resistance is the ability of a material to absorb and dissipate energies under impact or shock loading. The response to impact loads ranges from localized damage to total disintegration. Even local damage can be serious since it can lead to de-lamination and other effects. During impact loading fracture modes may be significantly different than static tensile failure. Composites generally show low values of impact energy compared to metals. The ways to increase the impact energy of the composites are being made the major area of research. The impact strength of the matrix and the composite is measured using the IZOD impact tester. The specimens are made according to the ASTM 256-88 standard. Samples are tested and their average values are recorded. The specimens are cut in to the dimensions of 120 mm×13mm×3mm and the notch was made at the centre of the specimen at 45˚ angle. Samples are tested and their average value is noted.

The impact strength of epoxy jute laminate showed the highest value when compared to the polyester jute laminate. The impact strength of Araldite epoxy laminate is 76 J/m² and the impact strength of Lapox B11 is 93 J/m².The figure below is IZOD Impact test.

D. COMPRESSION TEST:

The structural members commonly undergo compressive force. The axial stiffness of such members depends upon the cross-sectional area. Some of the composites have low compressive strength and this fact limits the full potential application of these composites. The compression testing of the composites is very challenging due to various reasons. The application of compressive load on the cross section can be directly applied the compressive load on the ends of a specimen. These specimens are smaller in size as compared to the tensile testing specimens. The compression test for the specimen is done according to ASTM D695 specifications. The compression test is done on the computerized universal testing machine. The samples were tested and their mean values are tabulated.

S NO	Specimen Label	Maximum Compressive Stress (MPa)	Young's Modulus (MPa)
1	Araldite epoxy jute laminate	87	1737
2	Lapox B11 jute laminate	103	2301

The performance of a composite mainly depends on the selection of the components and effective stress transfer from the matrix to the reinforcement. In order to achieve this, the interface bonding between the matrix and the reinforcement should be very small. The interface between bonding is judged by studying surface morphology. The scanning electron microscopy was done on Zeiss electron microscope at Indian Institute of Science, Bangalore. The specimens are cut in least possible dimensions without disturbing the orientation. The specimens used in Scanning Electron Microscopy are 8mm×8mm. Different magnifications are obtained to define morphology of the laminar composite.

Fibre and matrix interface is clearly visible in the SEM images provided for Lapox B11 composite. In the figure 5 at 200µm magnification the fibres are clearly visible in which the fibre assemblage and matrix without fibre is also visible clearly. This fig shows the perfect bonding of fibres with matrix

In figure below, the air gaps are clearly visible as indicated in the image. These air gaps reduce the strength of the composite. The air gaps are absorbed on the surface during the curing (hardening) of the composite. The magnification at this surface study is 20µm. The air gaps are nothing but voids, these voids are eliminated by following controlled temperature, pressure with respect to time.

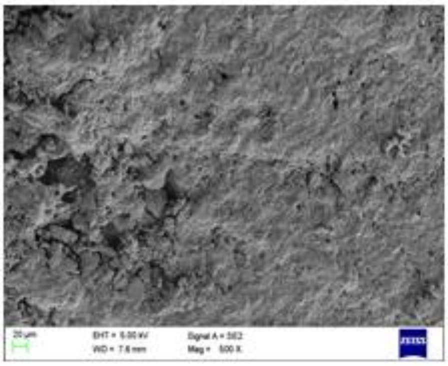


Figure4. SEM Analysis

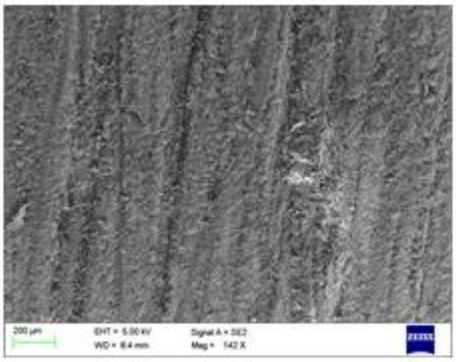


Figure5.SEM Analysis

IV. Conclusion:

The Lapox B11 epoxy jute laminar composites exhibited excellent mechanical and micro structural properties compared to the Araldite epoxy laminar composites. The Lapox B11 composites mostly reached the properties nearer to the glass fibre, carbon fibre reinforced polymers .The laminar composites exhibited best properties when the fibre is aligned in laminar type compared to other type of alignments. This work states that jute fibre in woven form can replace few synthetic fibre reinforced composites. Application of the jute fibre is concerned with in the fields of automobile sector, aviation, aerospace applications. They are mostly used to increase weight to strength ratio. They are used in light weight and high strength applications. These laminar composites when used with Lapox B11 and K11, K42 hardeners exhibits higher mechanical properties when compared to the epoxy resin (ARALDITE LY-556) and the hardener HY 951(73) matrix. The jute laminar composites can be used in the replacement of artificial fibres but they exhibit slight variation in their properties. These laminar composites with jute fibres are eco-friendly. The orientation of the fibre also plays major role in the specimen properties, this is examined and results showed better properties than random orientation.

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