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DEVELOPMENT AND PERFORMANCE ANALYSIS OF JUTE FIBER AND ALUMNI POWDER REINFORCED PHENOL FORMALDEHYDE HYBRID COMPOSITES

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ABSTRACT: *Increasing worldwide environmental awareness is encouraging scientists and engineers to concentrate on eco - friendly components available in natural resources. Continuous search is on by academic research and Industrial research for new materials since 20 th century. Composites, the wonder material with light-weight, high strength-to-weight ratio and stiffness properties have come a long way in replacing the conventional materials like metals, woods etc. Therefore, Composites of polymers both (thermoset and thermoplastic) with available natural resources received greater focus. Combination of materials with identifiable interface is denoted as composite. Composite has really revolutionized the concept high strength and low weight concept. Further natural fiber reinforce components are strong, stiff, light weight, recyclable with high mechanical properties, high electrical insulation properties for breakdown resistance Filler reinforced material consists of fillers embedded in or bonded to a polymer matrix with distinct inter phases. The fillers can be in the form of plastics, fibers, whiskers or flakes. The combination of filler with the matrix and natural fiber produces enhanced values of mechanical properties that cannot be achieved by either of the constituents acting alone. Composite Polymers are extensively used in many engineering applications such as automotive, sports goods, marine, electrical, industrial, household appliances, more sustainable construction and packing materials General tendency of man is to lead a comfortable life. For this, he needs new and useful material. Composite materials allow a great versatility of designs and offer many advantages over conventional materials. Polymer matrix can be processed at room temperature compared to other types of matrixes. Due to the availability various thermosetting resins such as epoxy, viny Lester, polyester, phenolic polyamides, cyanate ester etc, It is noted that though continuous search of composites is on at various Countries, scope for further requirements of human race is still to be explored in present work, Alumni powder with jute fiber reinforced phenol formaldehyde composites have been planned to make hybrid composite samples as per ASTM standards, using hand layup process. The treated and untreated samples of composites with variable percentage weights fiber loading will be used for testing the mechanical properties and thermal properties as per ASTM standards. Further evaluation of chemical resistance and electron microscopy (SEM) will be conducted for the performance of the composites. Recently, the demand for reinforced plastics from natural, sustainable, biodegradable, and environmentally friendly fibers has been rising worldwide. However, the main shortcoming of natural fibers reinforced plastics is the poor compatibility between reinforcing fibers and the matrix. Hence, it is necessary to form a strong attachment of the fibers to the matrix to obtain the optimum performance. In this work, chemical treatments (acid pretreatment, alkali pretreatment and scouring) were employed on jute fibers to modify them. The mechanical properties, surface morphology, and Fourier transform infrared spectra of treated and untreated jute fibers were analyzed to understand the influence of chemical modifications on the fiber. Then, jutefiber/epoxy composites with a unidirectional jute fiber organization were prepared.*

Basi cvi properties of the composites such as the void fraction, tensile strength, initial modulus, and elongation at break were studied. The better interfacial adhesion of treated fibers was shown by scanning electron microscope (SEM) images of fractured coupons. Hence, the chemical treatment of jute fiber has a significant impact on the formation of voids in the composites as well as the mechanical properties of jute fiber composites applications as in aerospace, automotive, medical science and marine industries. In this paper the mechanical behavior of jute fiber-aluminum (Al) powder polymer composite has been investigated experimentally. The materials selected for the studies were jute fiber and aluminum powder as the reinforcement and epoxy resin as the matrix. The hand lay-out technique was used to fabricate these composites. Composite plates were prepared by incorporating jute fiber and aluminum powder at 8 and 16 volume percent in epoxy matrix. Results showed that the overall tensile strength, impact property, hardness, Young's modulus and comparison of strength of hybrid composites (reinforced by both powder and fiber) is higher than other single reinforced composites. By incorporation of natural fibers and metal powder into the polymer, the mechanical properties almost enhanced to greater extent. It can thus be inferred that jute fiber and Al powder can be a very potential candidate in making of composites for low load bearing.

Keywords: *Jute fiber, composite, chemical, surface openness, physical properties ,tensile properties, Polymer composite, mechanical property, phenol formaldehyde ,alumini powder.*

I. INTRODUCTION

During the last few decades, composite materials have gained much attention from researchers in the fields of materials science and engineering materials. Broadly, composite materials can be categorized into three categories in terms of the matrix used: polymer matrix composites, metal matrix composites, and ceramic matrix composites. Among them, polymer matrix composites have various advantages over the other two, including a lower volume-to-weight ratio, a higher specific strength-to-weight ratio, the ability to be formed into different shapes and sizes, resistance to corrosion, as well as a simple manufacturing process, recyclability and lower cost .. Therefore, fiber-reinforced plastics have successfully replaced their heavy metal andceramic as well as expensive engineering plastic counterparts. In general, fiber-reinforced plastics are either made up of thermoplastic or thermoplastic resin as a matrix, with either synthetic or natural fibers as a reinforcing material. Due to the large amounts of debris they generate and the scarcity of fossil fuels, more and more attention has been paid to the use of sustainable, biodegradable, and green composites. Natural fiber-reinforced composites fulfill these requirements, however, there is still much to be explored to gain the full benefit of these composites. Jute is the second most natural and biodegradable fiber. Jute fiber is an excellent alternative.

when strength, thermal conductivity, and cost are major concerns. In addition, jute fibers are eco-friendly. Nowadays, jute fiber-reinforced polymer composites have become an important area of research. Typically, jute fiber is used for basic and low-end textile products. If the properties of jute could be modified in favor of high value and technical textiles, not only the cost but also the environment would benefit a great deal. Jute is composed of cellulose (45–71.5%), hemicelluloses (13.6–21%), and lignin (12–26%). Lignin, due to the many aromatic rings inside of it, is responsible for mechanical support Any material besides cellulose that hampers the smoothness, pliability, and fineness of jute is denoted as gum.

II. LITERATURE REVIEW

When compared with Titanium oxide, Calcium Carbonate, ALUMINA The tensile strength and yield strength values of the KGR6 are higher than that of remaining specimen. The KGR6

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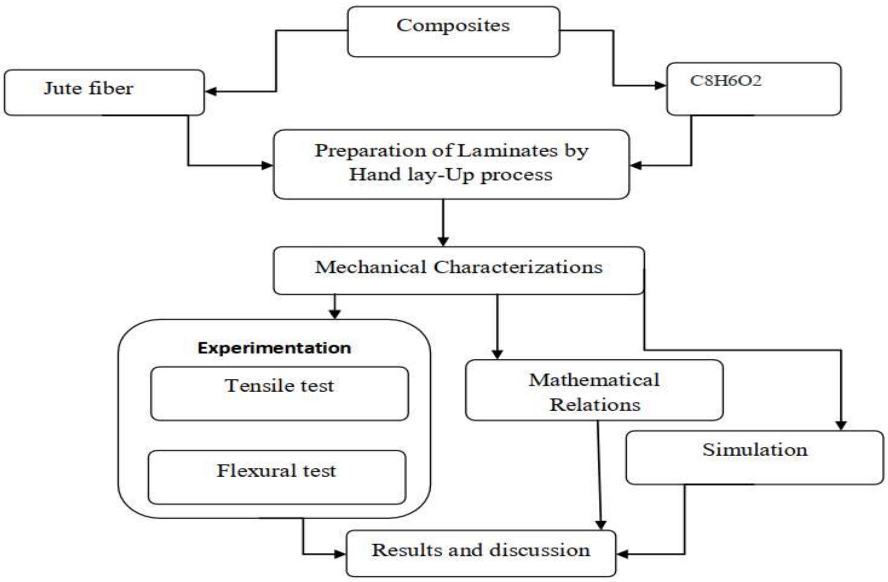
specimens have the capability to withstand higher load. It reflects the high stiffness and rigidity of KGR6 compared to remaining categories. The percentage elongation indicates that the KCC6 and KTO6 specimen has ductility and toughness. In this present work, it is clearly stated that KGR6 is recommended for tensile application . The JUTE FIBER-Graphene nano composites are tested for the mechanical property In addition, we also witnessed the appreciable change in strength of fiber nearly 25% to 30%as 2% and 5% of the graphene is mixed with Phenol Formaldehyde by direct sonication process. As the percentage of graphene is increased further to 10% and 20% it's forlorn to see the drop in strength of the fiber. The results and plots clearly visualize that, the increase in ratio of nanocomposite will affect the interfacial property of the laminated due to which the strength of the fiber is dropped as the graphene ratio is exceed beyond 5% .

III. METHODOLOGY

The above flow chart illustrates the methodology of problem of this project. At the beginning we selected JUTE FIBER fiber and LY556 resin to fabricate fiber reinforced JUTE FIBER laminates. Hand lay-up is the first method of many manufacturing processes of composites which is simple and takes less time to fabricate. In this project laminate composites were fabricated.



To know the mechanical properties of the laminate, tensile & Flexural test were performed on the laminates. Further the results were discussed.The results of Hardness and Young modulus are presented in and comparison results are presented. Experimental results shows that maximum hardness number is obtained for hybrid b(both jute fiber and Al powder reinforcement) composites followed by single jute fiber or single Al powder composites. Hybrid composite exhibits high elastic modulus compared with others composites.

IV. SPECIFICATIONS OF THE SPECIMEN:

S.No	Name of the Component	Length	Width	Thickness
1	ASTM D 638 Standards	165 mm	18.86 mm	4.60 mm
2	ASTM D 790 Standards	127 mm	14.30 mm	4.90 mm

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V. FABRICATION

Two flat scratch less moulds are taken as the base of fabrication.The mould metal plate was cleaned with 80 grade fine emery paper in order to remove rust and unwanted particles, greased with acetone
with cotton waste and applied mould release agent (wax polish) and allowed it to dry for few minutes.

The fabrication of the polymer matrix composite was done at room temperature. The required materials JUTE FIBER fiber, LY556 Resin and HY951 Hardener. Laminatea was fabricated by pouring mixture of Phenol Formaldehyde resin and hardener by weight in a JUTE FIBER fiber of mould dimensions. The resin pored on the fiber should be distributed uniformly and for required bonding ,rolling device is used.

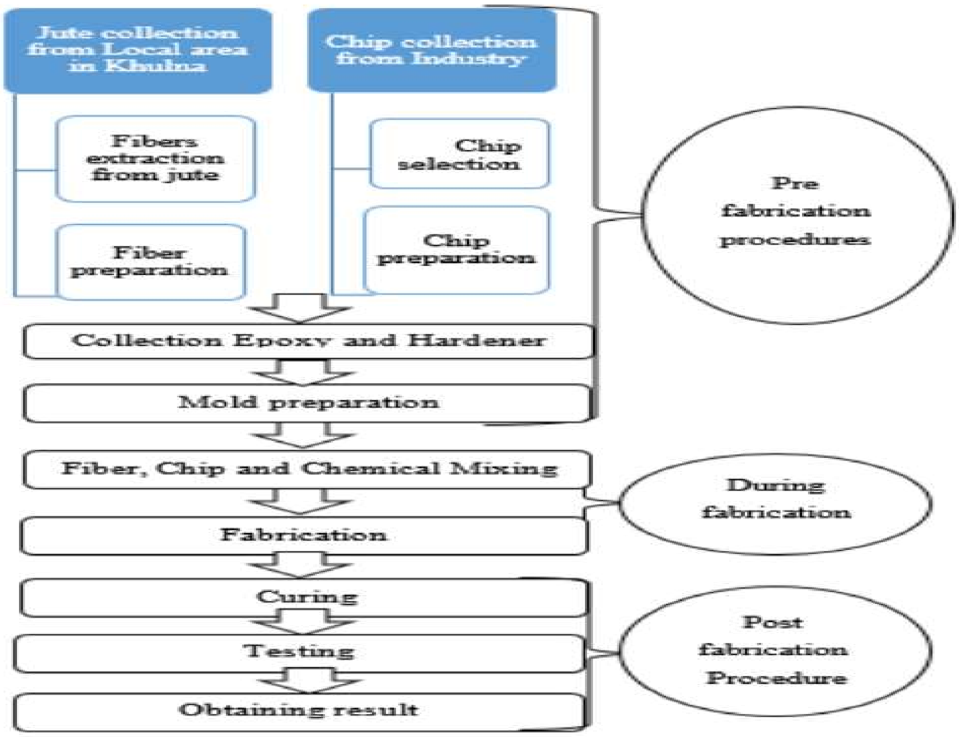

Fig . Fabrication process flow chart

Tensile and Flexural test were carried out using Universal Testing Machine for samples of bidirectional oriented JUTE FIBER fiber reinforced Phenol Formaldehyde resin based polymer composite laminates of different ALUMINA concentrations and results were discussedwhen compare to the single powder composites. However, single jute fiber reinforced composites how better strength results compare to the single Al powder composites. For analyzing the impact capability of the different specimens an impact test is carried out by impact test. The energy loss is found out on the reading obtained from the impact machine. Experimental results of impact testing of various composites with different weight fractions of reinforcement are presented in Table and the comparison results are presented in the results indicated that the maximum impact strength is obtained for hybrid composites.

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The layup assembly is pressed with the help of roller so that excess air between the layers is expelled out. The laminate is cured at ambient conditions for a period of about 24hrs. The laminate is prepared for different additive concentration of ALUMINA powder.The sampleswere removed from mould and test specimen were cut from carbon fiber laminate (sample) as per ASTM D 638 and ASTM D790 standards as shown in figure 22 for various ALUMINA concentrations after a curing period of 24 hours at room temperature.To avoid degradation of the material properties,a product called AGM 9 is used to be a stabilizer of fiber composite properties and prevent the fiber strength drop due to effect the moisture absorbtion from the air.After fabrication the laminate are kept in the oven for Post curing to 75oC for 45 minutes. the most affordable natural fibers and second only to cotton in the amount produced and variety of uses. Jute fibers are composed primarily of the plant materials cellulose and lignin. Jute fiber falls into the bast fiber category (fiber collected from bast, the phloem ofthe plant, sometimes called the "skin") along with kenaf, industril hemp, flax linen, ramie, etc.. The industrial term for jute fiber is *raw jute*. The fibers are off-white to brown, and 1–4 metres (3–13 feet) long. Jute is also called the "golden fiber" for its color and high cash value..



VI. TESTING OF THE SPECIMEN:

A Universal Testing Machine (UTM) , also known as a universal tester, materials testing machine or materials test frame, is used to test the tensile strength and compressive strength of materials. An earlier name for a tensile testing machine is a tensometer. The "universal" part of the name reflects that it can perform many standard tensile and compression tests on materials, components, and structures.

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Fig .Tensile test in Universal Testing Machine (UTM)   Fig. Flexural test

The specimen is placed in the machine between the grips and an extensometer if required can automatically record the change in gauge length during the test. If an extensometer is not fitted, the machine itself can record the displacement between its cross heads on which the specimen is held. However, this method not only records the change in length of the specimen but also all other extending / elastic components of the testing machine and its drive systems including any slipping of the specimen in the grips.

VII STRUCTURAL ANALYSIS OF TENSILE & FLEXURALSPECIMEN:

7.1 SIMULATION WITH ASSUMPTION LOADS:

TENSILE TEST:

Trial	Load	Stress	Elements	Nodes	Element Size
1	500 N	12.24 MPa	8737	15058	2 mm
2	1000 N	24.47 MPa	8737	15058	2 mm
3	1500 N	36.71 MPa	8737	15058	2 mm
4	2000 N	48.95 MPa	8737	15058	2 m

Table 1:Simulation Results with Assumption Loads (Tensile Test)

FLEXURAL TEST:

Trial	Load	Stress	Elements	Nodes	ElementSize
1	500 N	77.22 MPa	1968	3575	3 mm
2	1000 N	154.4 MPa	1968	3575	3 mm
3	1500 N	231.7 MPa	1968	3575	3 mm
4	2000 N	308.9 MPa	1968	3575	3 mm

Table 2: Simulation Results with Assumption Loads (Flexural Test)

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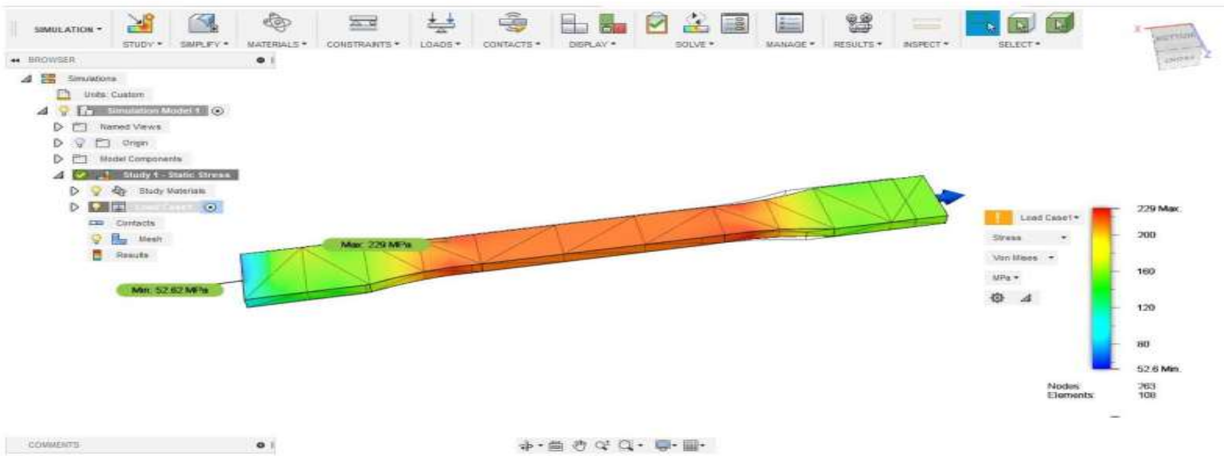

Fig : JUTE FIBER + 3% ALUMINA simulation with experimental load (Tensile Test).

Load	Nodes	Elements	Stress	Strain	Displacement	Reaction Forces
11513N	263	108	232.5 MPa	0.001719	0.2358 mm	3590 N

Table 3: Simulation Results JUTE FIBER + 3% ALUMINA (Tensile Test)

Above figure shows Analysis image of Tensile JUTE FIBER+3% ALUMINA with given Experimental load 11513N , load applied in principal x-axis, stress developed is 232.5 MPa

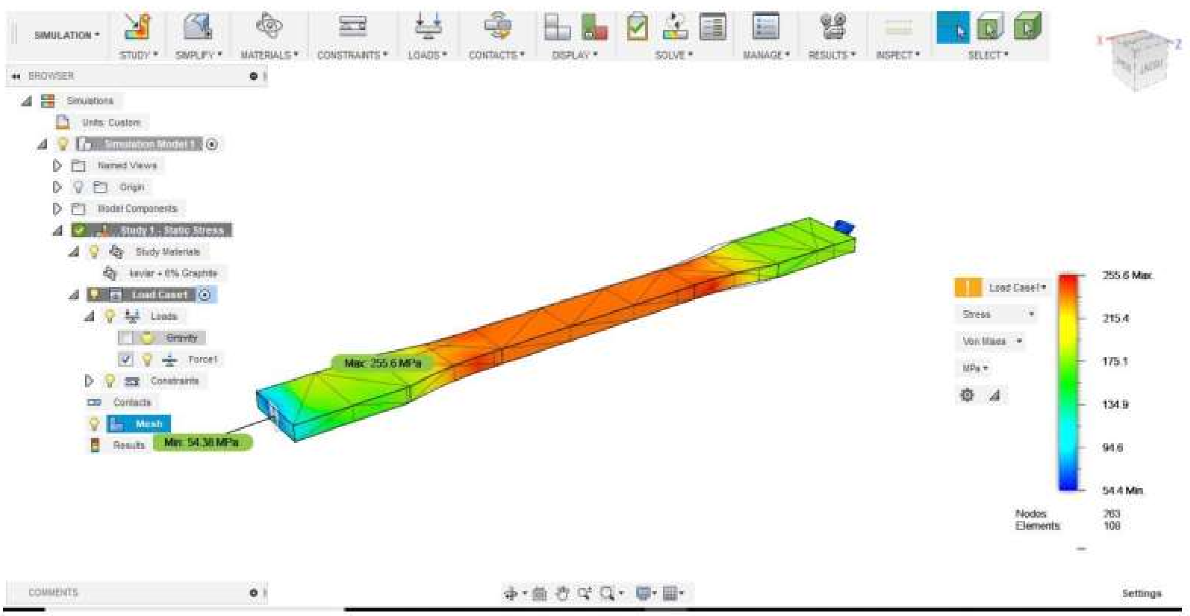

Fig : JUTE FIBER + 6% ALUMINA simulation with experimental load (Tensile Test).

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Load	Nodes	Elements	Stress	Strain	Displacement	Reaction Forces
12847N	263	108	258.2N	0.001912	0.2623 mm	4015 N

Table 4 : Simulation Results JUTE FIBER + 6% ALUMINA (Tensile Test)

Above figure shows Analysis image of Tensile JUTE FIBER+6% ALUMINA with given Experimental load 12847.0N , load applied in principal x-axis, stress developed is 258.6 MPa.

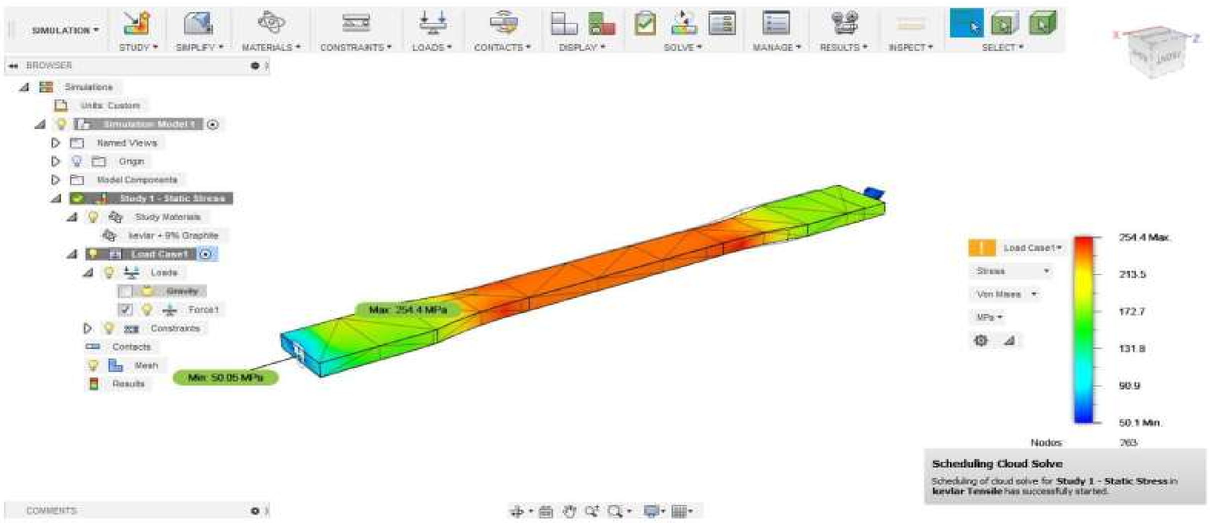

Fig : JUTE FIBER + 9% ALUMINA simulation with experimental load (Tensile Test).

Load	Nodes	Elements	Stress	Strain	Displacement	Reaction Forces
12788N	263	108	259.8N	0.001896	0.2602	4002 N

Table 5: Simulation Results JUTE FIBER + 9% ALUMINA (Tensile Test)

Above figure shows Analysis image of Tensile JUTE FIBER+9% ALUMINA with given Experimental load 12788 N , load applied in principal x-axis, stress developed is 259.8 MPa.

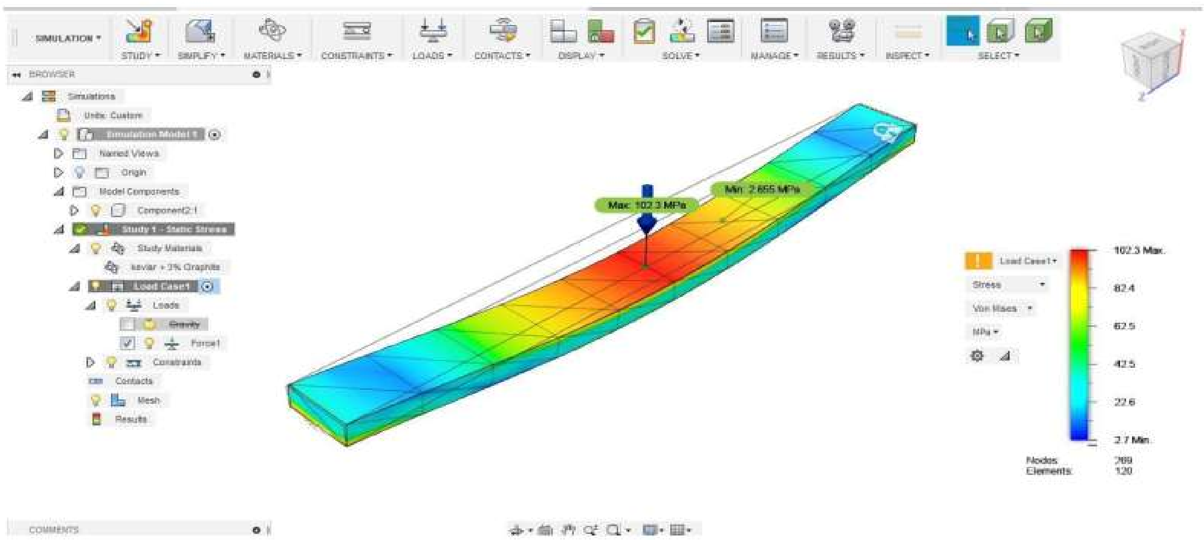

Fig : JUTE FIBER + 3% ALUMINA simulation with experimental load (Flexural Test).

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Load	Nodes	Elements	Stress	Displacement
333.4 N	269	120	51.01 MPa	0.388 mm

Table 6: Simulation Results JUTE FIBER + 3% ALUMINA (Flexural Test)

Above figure shows Analysis image of Flexural JUTE FIBER+3% ALUMINA with givenExperimental load 333.4N , load applied in principal x-axis, stress developed is 51.01 MPa.

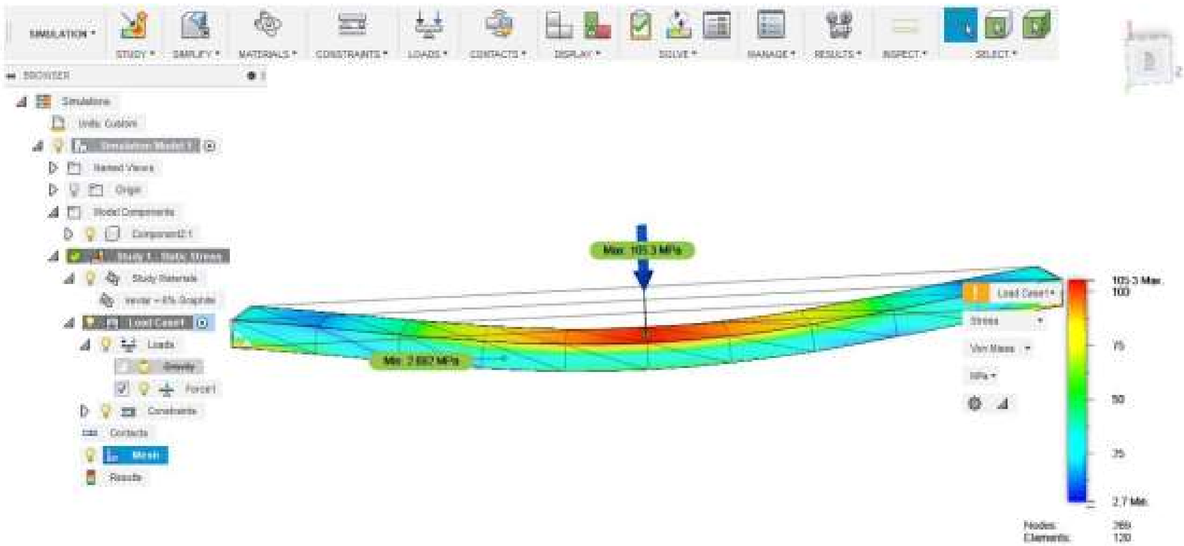

Fig : JUTE FIBER + 6% ALUMINA simulation with experimental load (Flexural Test)

Load	Nodes	Elements	Stress	Displacement
343.2 N	269	120	52.46 MPa	0.3975 mm

Table 7: Simulation Results JUTE FIBER + 6% ALUMINA (Flexural Test)

Above figure shows Analysis image of Flexural JUTE FIBER+6% ALUMINA with given Experimental load 343.2N , load applied in principal x-axis, stress developed is 52.46 MPa.

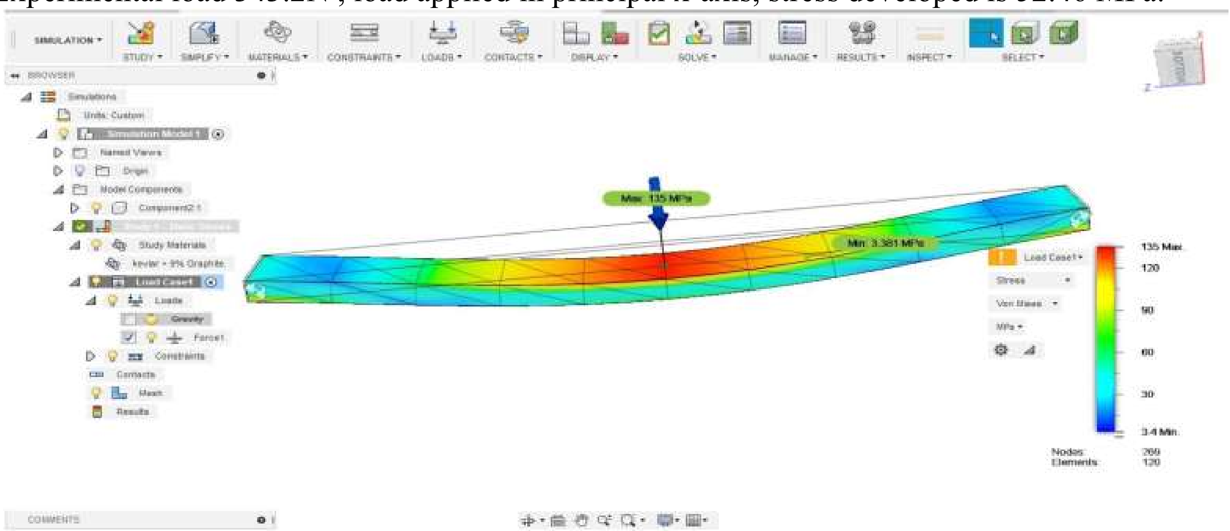

Fig : JUTE FIBER + 9% ALUMINA simulation with experimental load (Flexural Test).

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Load	Nodes	Elements	Stress	Displacement
440.2 N	269	120	67.22MPa	0.5075 mm

Table 8: Simulation Results JUTE FIBER + 9% ALUMINA (Flexural Test)

Above figure shows Analysis image of Flexural JUTE FIBER+9% ALUMINA with given Experimental load 440.2N , load applied in principal x-axis, stress developed is 67.22 MPa.

VIII. RESUTS AND DISCUSSIONS:

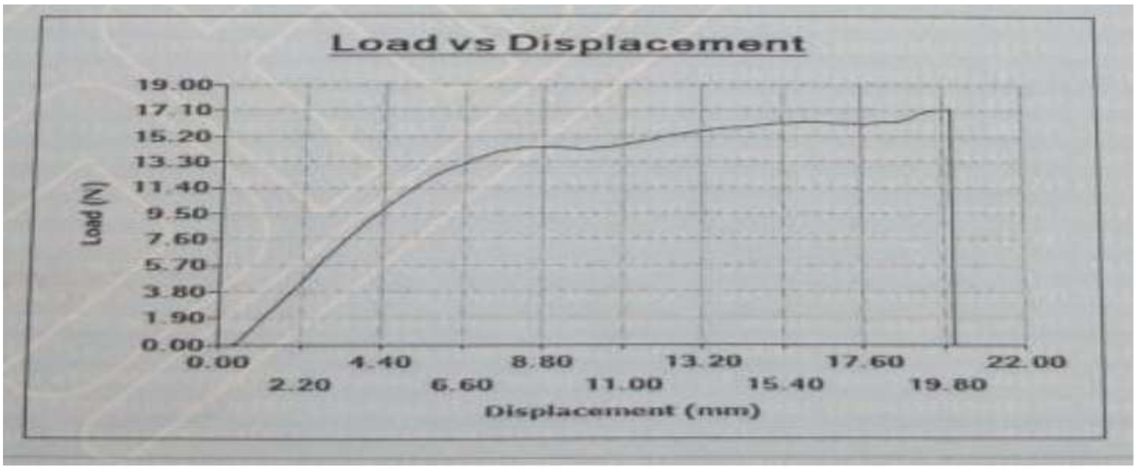
The obtained specimens are finished by using emery paper. The tensile & Flexural specimens from the laminates are subjected to uni-axial load using 20KN capacity Universal Testing machine with the surrounding room temperature of 320C.The load was applied till fracture with a grip displacement rate was maintained at 8 mm/min of Span Length. Test was done 3 times for each ALUMINI concentration and the tensile& Impact properties of composite laminates with varying ALUMINI concentration are calculated and tabulated respectively.

8.1. FLEXURAL TEST REPORT:

Identification : Jute fiber + 4% Aluminium Test procedure : ASTMD790

Input data	**Results**
Span Length : 80 mm	Ultimate Load : 17.2 N
TC No : M-I22-10075	Flexural Strength : 6.65 N/**mm2**
Specimen Type : Flat	
Specimen width : 14.05 mm	
Specimen Thickness : 4.70 mm	
C/S Area : 66.04 **mm2**	

Table 9 : Flexural Test Report with 4% Aluminium



FLEXURAL TEST REPORT

Identification: Jutefiber+8%Aluminium Test procedure : ASTM D790

Input Data	Results
TC No : M-122-10075	Ultimate Load : 15.8 N
Specimen type : Flat	Flexural Strength : 5.52 N/mm2

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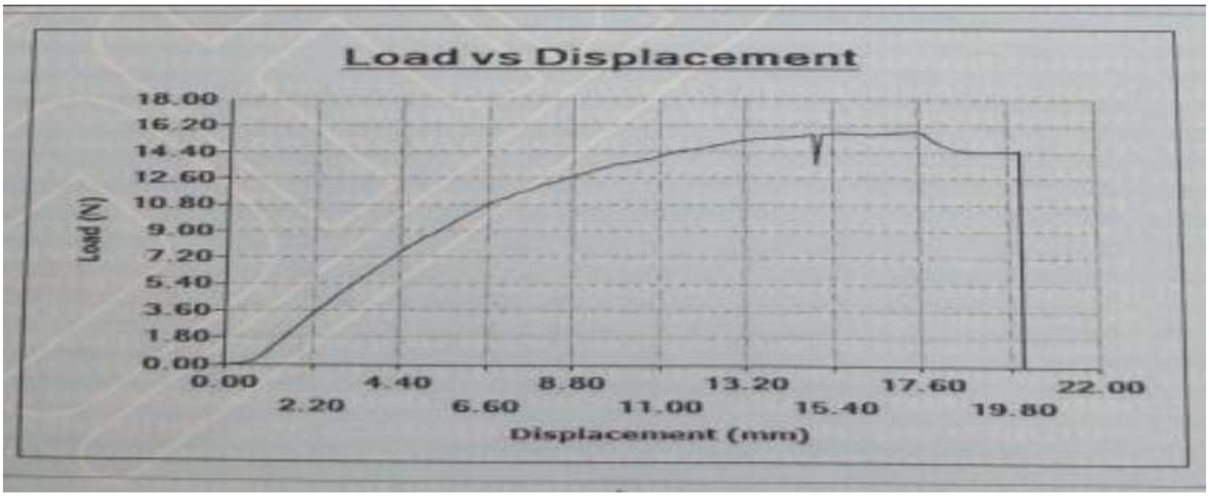
Specimen width : 14.30 mm	
Specimen Thickness : 4.90 mm	
C/S Area : 70.07 mm2	
Span Length : 80 mm	

Table 10 : Flexural Test Report with 8% Aluminium

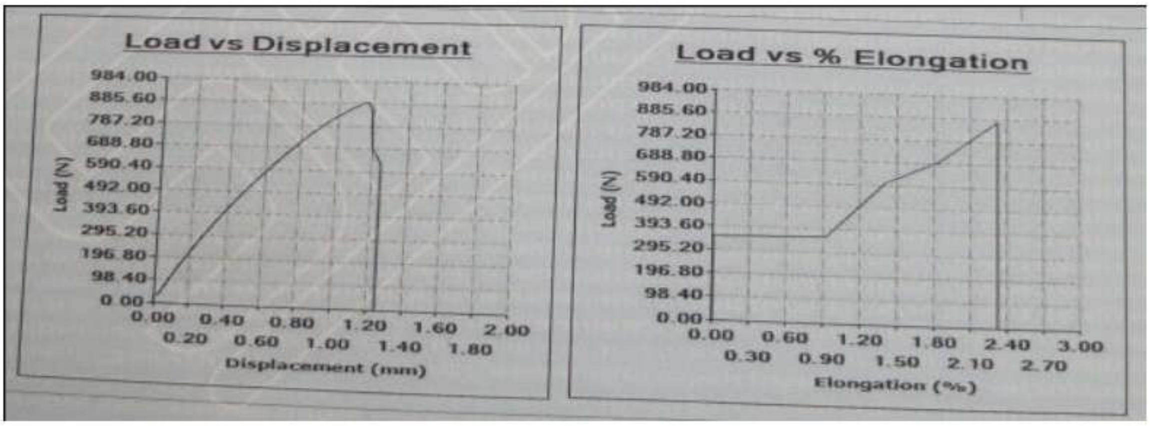


8.2. TENSILE TEST REPORT

Identification : Jute fiber + 4% Aluminium Test procedure : ASTM D 638

Input Data	Results
TC No : M-I22-1075-1	Ultimate Load : 894 N
Specimen Type : Flat	Ultimate Tensile Strength : 8.23 N/mm2
Specimen width : 19.40 mm	Maximum Extension : 0.58 mm
Specimen Thickness : 5.60 mm	% Elongation : 2.32 %
C/S Area : 108.64 mm2	
Original Gauge Length : 0.00 mm	
Final Gauge Length : 0.00 mm	

Table 11:Tensile test Report with 4%Aluminium



TENSILE TEST REPORT

Identification : Jute fiber + 8% Aluminium Test procedure : ASTM D 638

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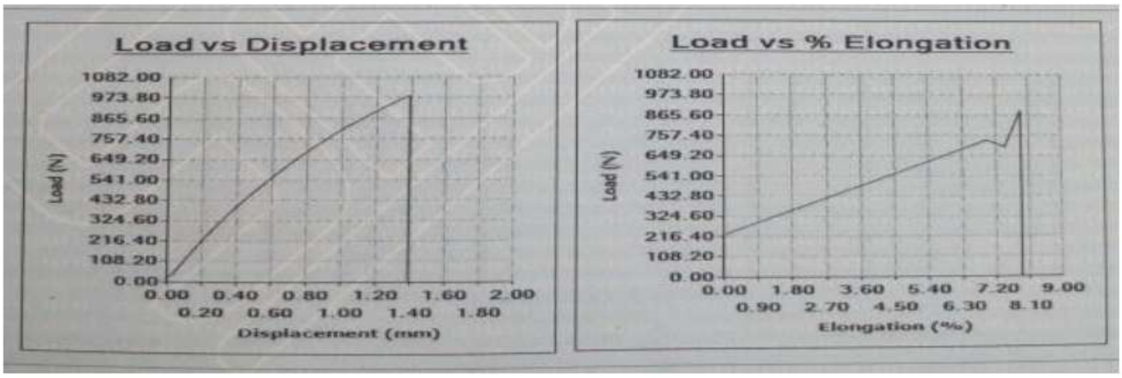
Input Data	Results
TC No : M-I22-1075-3	Ultimate Load : 985.45 N
Specimen Type : Flat	Ultimate Tensile Strength : 11.36 N/mm2
Specimen width : 18.86 mm	Maximum Extension : 1.97 mm
Specimen Thickness : 4.60 mm	% Elongation : 7.88 %
C/S Area : 86.76 mm2	
Original Gauge Length : 0.00 mm	
Final Gauge Length : 0.00 mm	

Table 12:Tensile test Report with 8%Aluminium



8.3. IMPACT TEST REPORT:

Material Identification : Jute Fiber	Test Procedure : ASTM D 256
Equipment Used : KRYSTAL EQUIPMENTS	Type of Impact : CHARPY – V
Notch Depth : 2 mm	
Notch Angle : ***45°***	
Specimen Size : 10 x 6 x 55 mm	
Impact test Temperature : At Room Temperature	

Table 13:Impact Test Materials

Sl.NO	**Location of the Sample**	**Impact 1**	**Impact 2**	**Impact 3**	**Average**
1	Jute fiber + 4% Aluminium	2	0	0	2
2	Jute fiber + 8% Aluminium	2	0	0	2

Table : Imapact Test Report Results

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IX. CONCLUSION:

Based on the experimental results the effect of additives on Tensile and flexural behavior of JUTE FIBER Fiber fabric at laminate level to explore an alternative skin material for the outer body of aerospace applications and machines with different ALUMINA concentration ,the following conclusions

are drawn From the above results. By employing pressurehull without bolts for the same load carrying capacity, there is a reduction in are 32%~41% higher than pressurehull withbolts and 52~63% stiffer than the pressurehull with bolts**.**

The Tensile Strength of JUTE FIBER + 4%ALUMINA has increased by 2.32% and JUTE FIBER + 8%ALUMINA has increased by 7.88% than JUTE FIBER + 3% ALUMINA..

The Flexural Strength of JUTE FIBER + 4% ALUMINA has increased by 6.65% and JUTE FIBER +

8% ALUMINA has increased by 8.23% and than JUTE FIBER + 3% ALUMINA.

With this work JUTE FIBER with ALUMINA is recommended for Tensile and Flexural application. Hence the present study not only discloses that different proportions of ALUMINA overseen through the polymer promotes the performance of composites, but that unique tailored properties are improved by changing the proportions of the ALUMINA filler on the matrix. This researchindicates that the mechanical properties are mainly dependent on the fiber Filler (ALUMINA) .

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