FABRICATION AND ANALYSIS OF CALATROPIC GIGANTEA-GFRP IN AIRCRAFT STRUCTURE

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ABSTRACT:

The composite materials are replacing the traditional materials, because of its superior properties such as high tensile strength, low thermal expansion, high strength to weight ratio. The developments of new materials are on the anvil and are growing day by day. Fiber composites such as Calotropis gigantea– GFRP became more attractive due to their better properties which are using for Aircraft applications. In this connection we are fabricating Calotropis gigantea– GFRPcomposite with two different resins, vinyl resin and polypropylene resin. After fabricated Calotropis gigantea– Gyrocompasses send for mechanical tests like Tensile, flexural, and Impact for experimental study.

INTRODUCTION:

The composites industry has begun to recognize that the commercial applications of composites promise to offer much larger business opportunities than the aerospace sector due to the sheer size of transportation industry. Thus the shift of composite applications from aircraft to other commercial uses has become prominent in recent years. Increasingly enabled by the introduction of newer polymer resin matrix materials and high performance reinforcement fibers of glass, carbon and aramid, the penetration of these advanced materials has witnessed a steady expansion in uses and volume. The increased volume has resulted in an 8 expected reduction in costs. High performance FRP can now be found in such diverse applications as composite armoring designed to resist explosive impacts, fuel cylinders for natural gas vehicles, windmill blades, industrial drive shafts, support beams of highway bridges and even paper making rollers. For certain applications, the use of composites rather than metals has in fact resulted in savings of both cost and weight. Some examples are cascades for engines, curved fairing and fillets, replacements for welded metallic parts, cylinders, tubes, ducts, blade containment bands etc. Further, the need of composite for lighter construction materials and more seismic resistant structures has placed high emphasis on the use of new and advanced materials that not only decreases dead weight but also absorbs the shock & vibration through tailored microstructures. Composites are now extensively being used for rehabilitation/ strengthening of pre-existing structures that have to be retrofitted to make them seismic resistant, or to repair damage caused by seismic activity. Unlike conventional materials (e.g., steel), the properties of the composite material can be designed considering the structural aspects.Yan Le at all presents a summary of recent developments of sisal fiber and its composites. The properties of sisal fiber itself interface between sisal fiber and matrix, properties of sisal fiber-reinforced composites and their hybrid composites have been reviewed. Suggestions for future work are also given.

Natural Fiber Reinforced Composites:

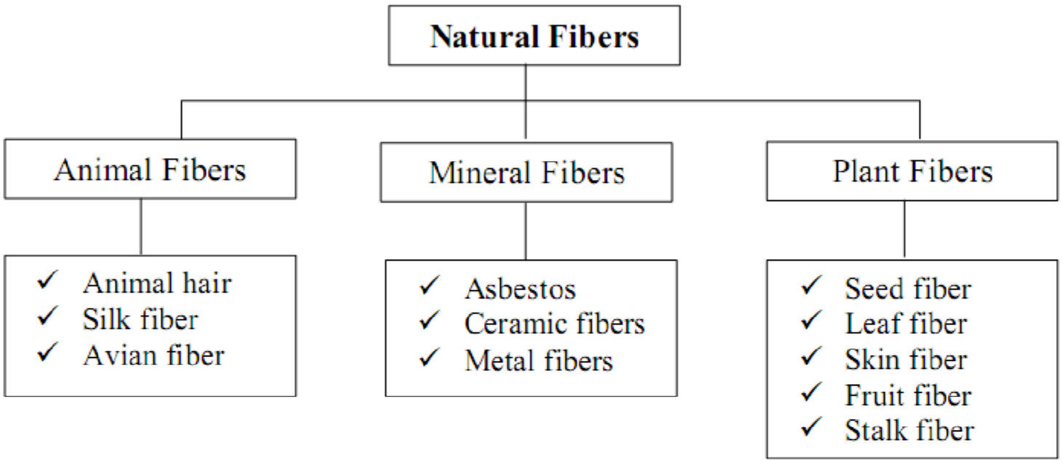

Fig 1.5 Classification of natural fiber

include those made from plant, animal and mineral sources. Natural fibers can be classified according to their origin. The detailed classification is shown in Figure 1.5.

Animal Fiber:

Animal fiber generally comprise proteins; examples mohair, wool, silk, alpaca, angora. Animal hair (wool or hair) are the fibers taken from animals or hairy m ammals.

Mineral fiber:

Mineral fibers are naturally occurring fiber or slightly modified fiber procured from minerals. These can be categorized into the following categories: Asbestos is the only naturally occurring mineral fiber. Variations are serpentine and amphiboles, anthophyllite. Ceramic fibers includes glass fibers (Glass wood and Quartz), aluminium oxide, silicon carbide, and boron carbide. Metal fibers includesaluminium fibers.

Plant fiber:

Plant fibers are generally comprised mainly of cellulose: examples include cotton, jute, flax, ramie, sisal and hemp. Cellulose fibers serve in the manufacture of paper and cloth. This fiber can be further categorizes into following as Seed fiber are the fibers collected from the seed and seed case e.g. cotton and kapok. Leaf fiber are the fibers collected from the leaves e.g. sisal and agave.

MATERIALS USED:

- Polypropylene
- Vinyl
- Hardener (HY-951) ▪ Natural Fibers (Calotropisgigantea– GFRP)
- NaOH Solution

Hardener (HY-951)

Hardener is a curing agent for epoxy or fiberglass. Resin requires a hardener to initiate curing; it is also called as catalyst, the substance that hardens the adhesive when mixed with resin.

Natural fibers such as Calotropic gigantea – GFRP composites:

Fiber-reinforced polymer composites have played a dominant role for a long time in a variety of applications for their high specific strength and modulus. The manufacture, use and removal of traditional fiber–reinforced plastic, usually made of glass, carbon or aramid fibers–reinforced thermoplastic and thermoset resins are considered critically because of environmental problems.

NaOH Solution:

Sodium Hydroxide (NaOH) is an alkaline solution used to enhance the surface morphology of natural fibers

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METHODOLOGY:

It is a large shrub growing to 4 m (13 ft) tall. It has clusters of waxy flowers that are either white or lavender in colour. Each flower consists of five pointed petals and a small "crown" rising from the center which holds the stamens. The aestivation found in calotropis is valvate i.e. sepals or petals in a whorl just touch one another at the margin, without overlapping. The plant has oval, light green leaves and milky stem. The latex of Calotropisgiganteacontains cardiac glycosides, fatty acids, and calcium oxalate.

- • It is Commercially available.
- • It is fully biodegradable and highly renewable resource.
- • It fiber is exceptionally durable and a low maintenance with minimal wear and tear.

Fig3.2.1: Sisal Fiber

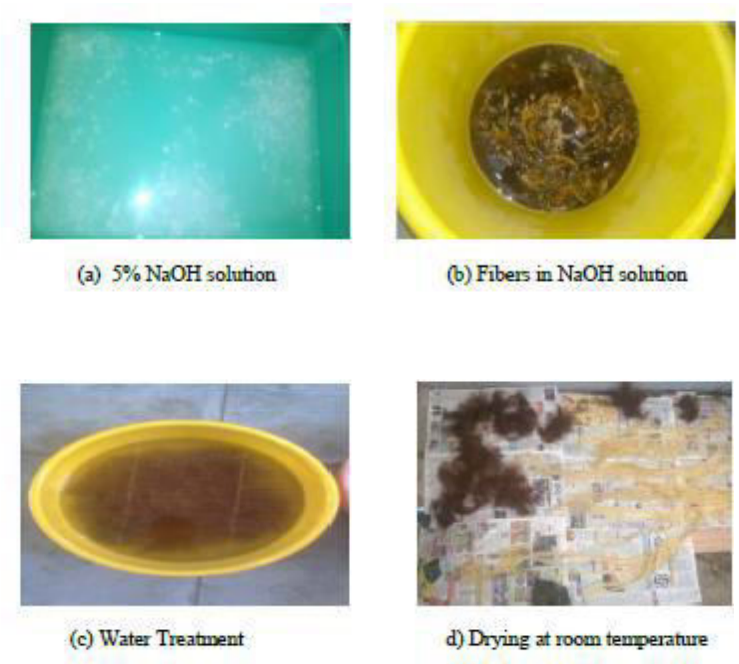
Polypropylene:

Polypropylene is provided by the Indian petrochemicals limited, and it has the melting temperature of 175C-180OC and the melted polypropylene flows at rate of 11g/10min. Polypropylene of 1110MA grade is used for injection molding. Since there are only three grades for injection molding they are 1030MG,1250MG/MA and 1110MA.

Fig3.2.4: Polypropylene

Vinyl Ester, or Vinylester, is a **resin** produced by the esterification of an epoxy **resin** with an unsaturated monocarboxylic acid. The reaction product is then dissolved in a reactive solvent, such as styrene, to approximately 35–45 percent content by weight.

The fibers were left to treat with 5% NaOH for 3-4 hrs. Later they were drawn and dried under sunlight fo r 1-2 hours.

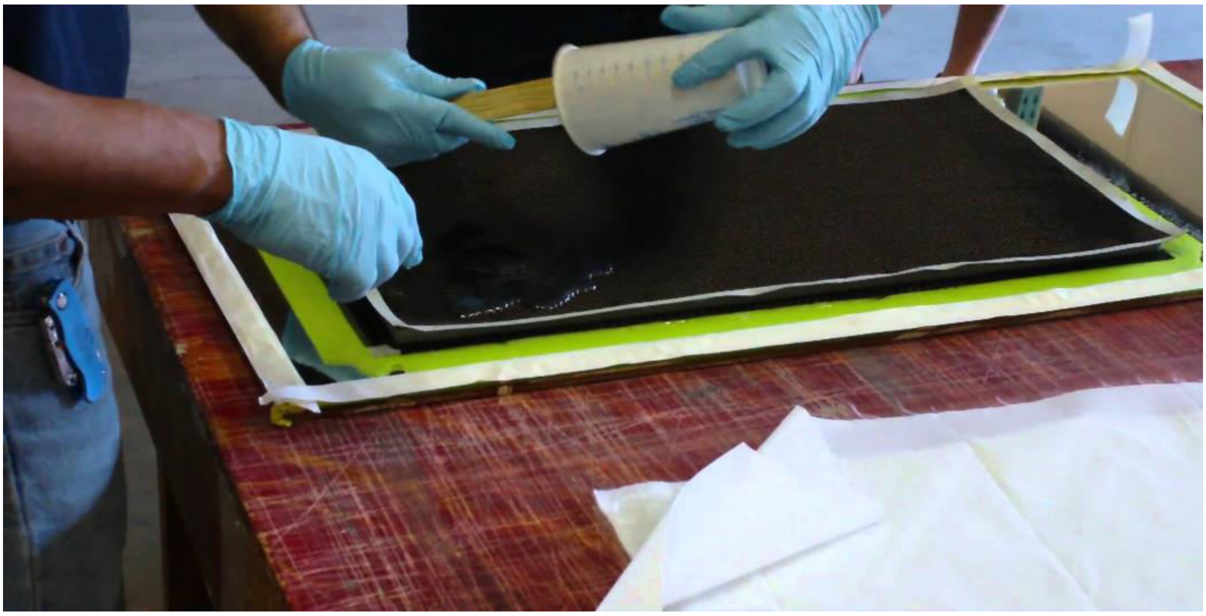


(a) 5% NaOH solution (b) Fibers in NaOH solution

(c) Water Treatment d) Drying at room temperature

Fig 3.2.4: Surface Treatment with NaOH

This standard is for determination of tensile properties for fiber reinforced composite which was prepared by the ISO plastics (Standard: ISO 527-4) of the international organization of standardization and its dimensions is shown in the figure 1. Standard ASTM E23 (Type: IZOD Impact Test) is for determination of impact strength & toughness for fiber reinforced composite. The test specimen is machined to a square section with one notch as shown in figure 4. The specimen for compressive test is prepared according to Standard: IS 13975 of ISO and the dimensions are shown in the figure 7



3.2.7: Sample preparation by wet hand lay-up process

3.2.8: Sample

RESULTS and discussion:

Tensile test:

The dimensions, gauge length and cross-head speeds are chosen according to the ASTM D638 standard. A tensile test involves mounting the specimen in a machine and subjecting it to the tension. The testing process involves placing the test specimen in the testing machine and applying tension to it until it fractures. The tensile force is recorded as a function of the increase in gauge length. During the application of tension, the elongation of the gauge section is recorded against the applied force.The specimen size is 165x24x5mm.The different composite specimen samples are tested in the universal testing machine (UTM) and the samples are left to break till the ultimate tensile strength occurs. The sample graph generated directly from the machine for tensile test with respect to load and displacement for Calotropisgigantea– GFRP with vinyl resin and polypropylene resin.The results indicated that Calotropisgigantea– GFRP with vinyl resin and polypropylene resinspecimen gives below.

TENSILE TEST REPORT

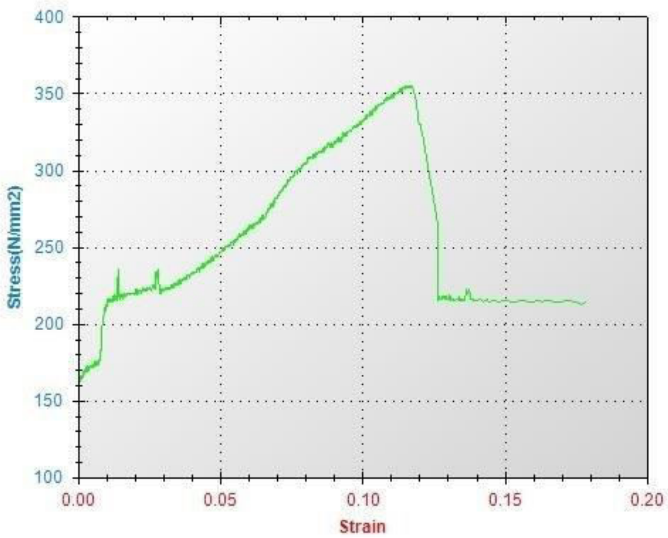
Machine Model	TUE-C-600	Test File Name	1602_2016.Utm
Machine Serial No	2014 /65	Date	09/03/2019
Customer Name	ARUN & BATCH	Customer Address	DSCET
Lot No.	8	Test Type	Tensile
Order No	1	Heat No.	

Input Data

Specimen Shape	Flat	
Material Type	20% CG + Vinyl RESIN	
Specimen Description	S1	
Specimen Width	20	mm
Specimen Thickness	4	mm
Gauge Length For % Elog.	33	mm
Pre Load Value	0	kN
Max. Load	600	kN
Max. Elongation	250	mm
Specimen Cross Section Area	24	mm2
Final Specimen Width	5	mm
Final Specimen Thickness	3.5	mm
Final Gauge Length	37	mm

Output Data

Load At Yield	3.27	kN
Elongation At Yield	0.000	mm
Yield Stress	136.25	N/mm2
Load At Peak	8.520	kN
Elongation at Peak	3.890	mm
Tensile Strength	355.000	N/mm2
Load At Break	5.130	kN
Elongation At Break	5.890	mm
Breaking Strength	213.750	N/mm2
% Reduction Area	27.08	%
% Elongation	12.12	%



TENSILE TEST REPORT

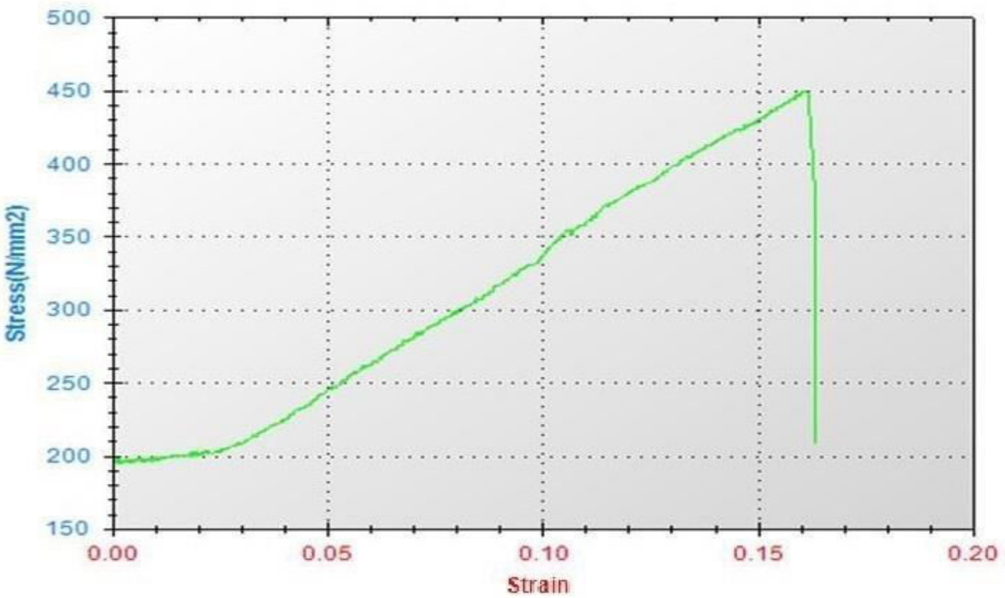
Machine Model	TUE-C-600	Test File Name	1608_2016.Utm
Machine Serial No	2014 /65	Date	09/03/2019
Customer Name	ARUN & BATCH	Customer Address	DSCET
Lot No.		Test Type	Tensile
Order No		Heat No.	

Input Data

Specimen Shape	Flat	
Material Type	20% CG + Polypropylene RESIN	
Specimen Description	S2	
Specimen Width	20	mm
Specimen Thickness	5	mm
Gauge Length For % Elog.	33	mm
Pre Load Value	0	kN
Max. Load	600	kN
Max. Elongation	250	mm
Specimen Cross Section Area	30	mm2
Final Specimen Width	5	mm
Final Specimen Thickness	4.5	mm
Final Gauge Length	41	mm
Final Area	22.5	mm2

Output Data

Load At Yield	4.89	kN
Elongation At Yield	0.000	mm
Yield Stress	163	N/mm2
Load At Peak	13.470	kN
Elongation at Peak	5.330	mm
Tensile Strength	449.000	N/mm2
Load At Break	6.270	kN
Elongation At Break	5.400	mm
Breaking Strength	209.000	N/mm2
% Reduction Area	25.00	%
% Elongation	24.24	%



The flexural specimens are prepared as per the ASTM D790 standard. The 3-point flexure test is the most common flexural test for composite materials. Specimen deflection is measured by the crosshead position. Test results include flexural strength and displacement. The testing process involves placing the test specimen in the universal testing machine and applying force to it until it fractures and breaks. The specimen used for conducting the flexural test. The tests are carried out at a condition of an average relative humidity of 50%.

The sample graph of flexural strength observed for the Calotropisgigantea– GFRP with vinyl resin and polypropylene resincomposites. The result indicated that the maximum applied load, after that it tends to decrease. The load VS time graph for different composites tested. The specimen of flexural test size is 110x15x5mm and the span of flexural test.

Flexural Test Report

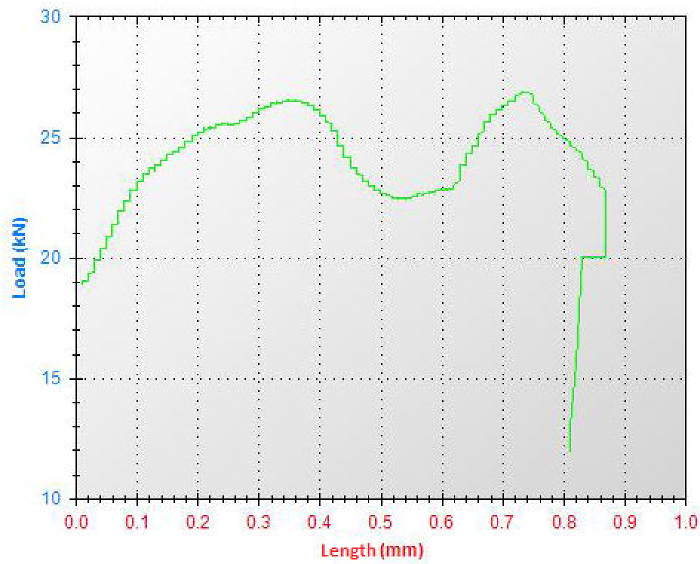
Machine Model	**TUE-C-600**	Test File Name	**1615_2016.Utm**
Machine Serial No	**2014 /65**	Date	**09/03/2019**
Customer Name	ARUN & BATCH	Customer Address	DSCET
Lot no		Test Type	**Flexural**
Work Order No.		Heat Number	

Input Data

Specimen Shape	Flat	
SpecimenType	20% CG + Vinyl RESIN	
Specimen Description	S1	
Specimen Width	10	mm
Specimen Thickness	4	mm
Pre Load Value	0	kN
Max. Load	600	kN
Max. Elongation	250	mm
Specimen Cross Section Area	56	mm2

Output Data

Load at Peak	26.880	kN
Elongation at Peak	0.740	mm
Flexural Strength	80.400	Mpa



Flexural Test Report

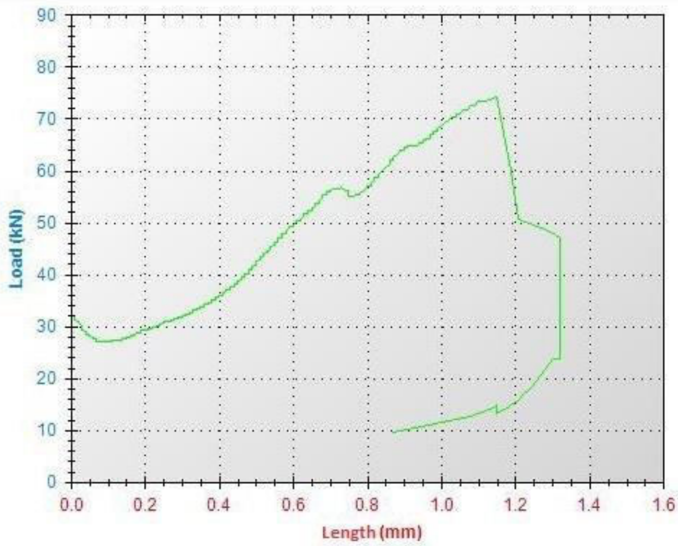
Machine Model	**TUE-C-600**	Test File Name	**1615_2016.Utm**
Machine Serial No	**2014 /65**	Date	**09/03/2019**
Customer Name	ARUN & BATCH	Customer Address	DSCET
Lot no		Test Type	Flexural
Work Order No.		Heat Number	

Input Data

Specimen Shape	Flat	
SpecimenType	20% CG + Polypropylene RESIN	
Specimen Description	S2	
Specimen Width	14	mm
Specimen Thickness	4	mm
Pre Load Value	0	kN
Max. Load	600	kN
Max. Elongation	250	mm
Specimen Cross Section Area	56	mm2

Output Data

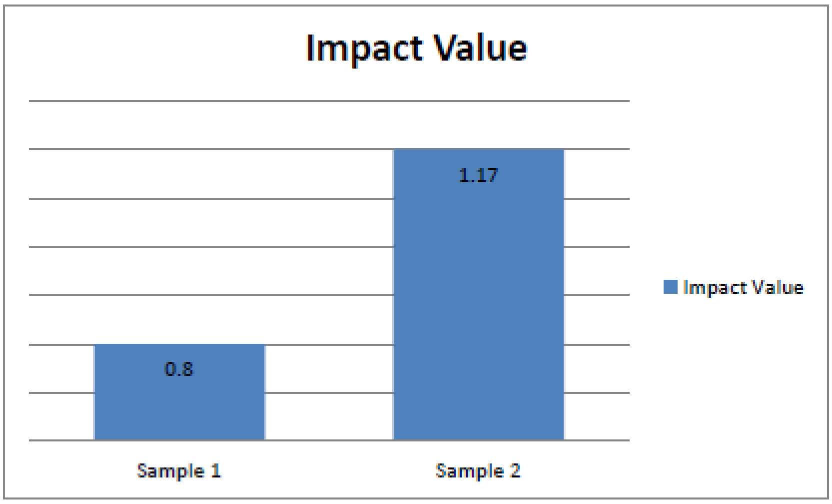
Load at Peak	26.880	kN
Elongation at Peak	0.740	mm
Flexural Strength	85.250	Mpa



The impact test specimens are prepared according to the required dimension following the ASTM-A370 standard. During the testing process, the specimen must be loaded in the testing machine and allows the pendulum until it fractures or breaks. Using the impact test, the energy needed to break the material can be measured easily and can be used to measure the toughness of the material and the yield strength.

The impact test carried out for the present investigation is Charpy impact test. The results indicated that the maximum impact strength is obtained for Calotropisgigantea– GFRP with vinyl resin and polypropylene resincomposites are 18J. The specimen size of impact test is 64x12x5mm.

sample	Joule	Joule/m (SI)	kg.cm/cm (ASTM)
s1	0.8	266.66	27.19
s2	1.17	373.33	38.06



CONCLUSION:

The experimental study shows a high Tensile strength, high Compressive strength, and high Impact strength by Calotropisgigantea– GFRP with polypropylene compared to vinyl resin and are best replacement for traditional materials in Aircrafts. From the detailed study and analysis process it is observed that Calotropisgigantea– GFRP composites are suitable for Aircraft applications. This can be improved in near future by varying the layup process and by adopting the natural fibres for making composites used for various Marine applications andalso the modern manufacturing technologies can be used like 3D printing.

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