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An Experimental Investigation of Glass Fibre with Prosopis Juliflora as Reinforced Polymer Composites

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Abstract: ***The main objective of this project is to investigate the mechanical properties of glass fibre reinforced with prosopis juliflora ash as reinforced polymer composite .(Glass fibre + Prosopis Juliflora ash) Composite is fabricated by adding prosopis julifora ash powder of 10% weight of glass fibre. In this research, fibre reinforced polymer were prepared with glass fibre and prosopis juliflora ash of glass fibre thickness 4-5mm. The resins used in this study are epoxy. The resins were synthesized at 10:1 fibre-resin weight percentages. The prepared composites were tested under ASTM standards to study the mechanical properties of the FRP composites such as Tensile strength, Flexural strength and Impact strength.***
Keywords: Glass fibre, prosopis juliflora, ASTM standards, epoxy resin, composite material.

I. INTRODUCTION

A. *Inrodution Of Composite Material*

Basic requirements for the better performance efficiency of an aircraft are high strength, high stiffness and low weight. The conventional materials such as metals and alloys could satisfy these requirements only to a certain extent. This lead to the need for developing new materials that can whose properties were superior to conventional metals and alloys, were developed.
A composite is a structural material which consists of two or more constituents combined at a macroscopic level. The constituents of a composite material are a continuous phase called matrix and a discontinuous phase called reinforcement.

Examples
1) Natural Composite
a) Wood: Cellulose fibers bound by lignin matrix
b) Bone: Stiff mineral “fibers” in a soft organic matrix permeated with holes filled with liquids

2) Man-Made Composites
a) Plywood: Several layers of wood veneer glued Together
b) Fiberglass: Plastic matrix reinforced by glass fibers

The most commonly used advanced composites are polymer matrix composites. These composites consists of a polymer such as epoxy, polyester, urethane etc., reinforced by thin-diameter fibers such as carbon, graphite, aramids, boron, glass
etc. Low cost, high strength and simple manufacturing principles are the reason why they are most commonly used in the repair of aircraft structures. To measure the relative mechanical advantage of composites, two parameters are widely used, namely, the specific modulus and the specific strength. These two parameter ratios are high in composites.
The building block of a laminate is a single lamina. Therefore the mechanical analysis of a lamina precedes that of a laminate. A lamina is an anisotropic and non-homogeneous material. But for approximate macro-mechanical analysis, a lamina is assumed to be homogeneous where the calculation of the average properties are based on individual mechanical properties of fiber and matrix, as well as content, packing geometry and shape of fibers. The lamina is considered as orthotropic, so it can be characterized by nine independent elastic constants: three Young’s moduli along each material axis, three Poisson’s ratio for each plane and three shear moduli for each plane. Once the properties for each lamina are obtained, properties of a laminate, made of those laminae can be calculated using those individual properties. In the highly competitive airline market, using composites is more efficient. Though the material cost may be higher, the reduction in the number of parts in an assembly and the savings in the fuel cost makes more profit. It also lowers the overall mass of the aircraft without reducing the strength and stiffness of its components.

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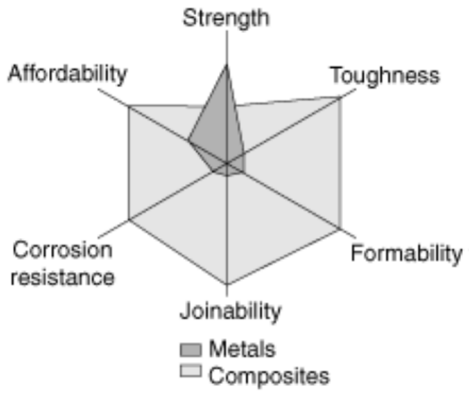


Fig.1.1: Primary Material Selection Parameter

B. Functions Of Reinforcement And Matrix

The primary functions of the matrix are to transfer stresses between the reinforcing fibers or particles and to protect them from mechanical and environmental damage whereas the presence of fibers or particles in a composite improves its mechanical properties such as strength, stiffness etc. A composite is therefore a synergistic combination of two or more micro-constituents which differ in physical form and chemical composition and which are insoluble in each other.

C. Classification Of Polymer Composites

Polymer composites can be classified into three groups on the basis of reinforcing material. They are:

1) Fiber reinforced polymer (FRP)
2) Particle reinforced polymer (PRP)
3) Structural polymer composites (SPC)

II. LITERATURE SURVEY

Po-Ching Yeh et.al., "Bearing strength of commingled boron/glass fiber reinforced aluminum laminates" (2012) observed that, the bearing properties of recently developed hybrid fiber/metal laminates, or commingled Boron/glass fiber Reinforced Aluminum laminates (COBRA), are investigated in this study. The bolt-type bearing tests on glass reinforced aluminum laminates (GLARE), non-commingled hybrid boron/glass/aluminum fiber/metal laminates (HFML) and COBRA were carried out as a function of *e*/*D* ratio, metal volume fraction, fiber volume fraction, and fiber orientation. Experimental results show that with the same joint geometry and metal volume fraction, the commingling of boron fibers improves the bearing strength of fiber/metal laminates. Observations show the boron/glass fiber prepreg, transverse to the loading direction, results in a bearing mechanism that effectively increases the bearing strength. The bearing strength of COBRA with longitudinal fibers is lower than that with transverse fibers due to the fact that shear out failure takes place before maximum bearing strength is reached. The experimental results show that, with only either transverse fiber orientation or longitudinal fiber orientation, COBRA with 18% boron fiber volume fraction possesses a higher bearing strength when compared to HFML with 6% boron fiber volume fraction. In addition to the properties in COBRA with parallel-plies commingled prepreg, the bearing properties of various COBRA with [0°/90°] and [0°/90°/90°/0°] cross-ply commingled prepregs are also discussed.

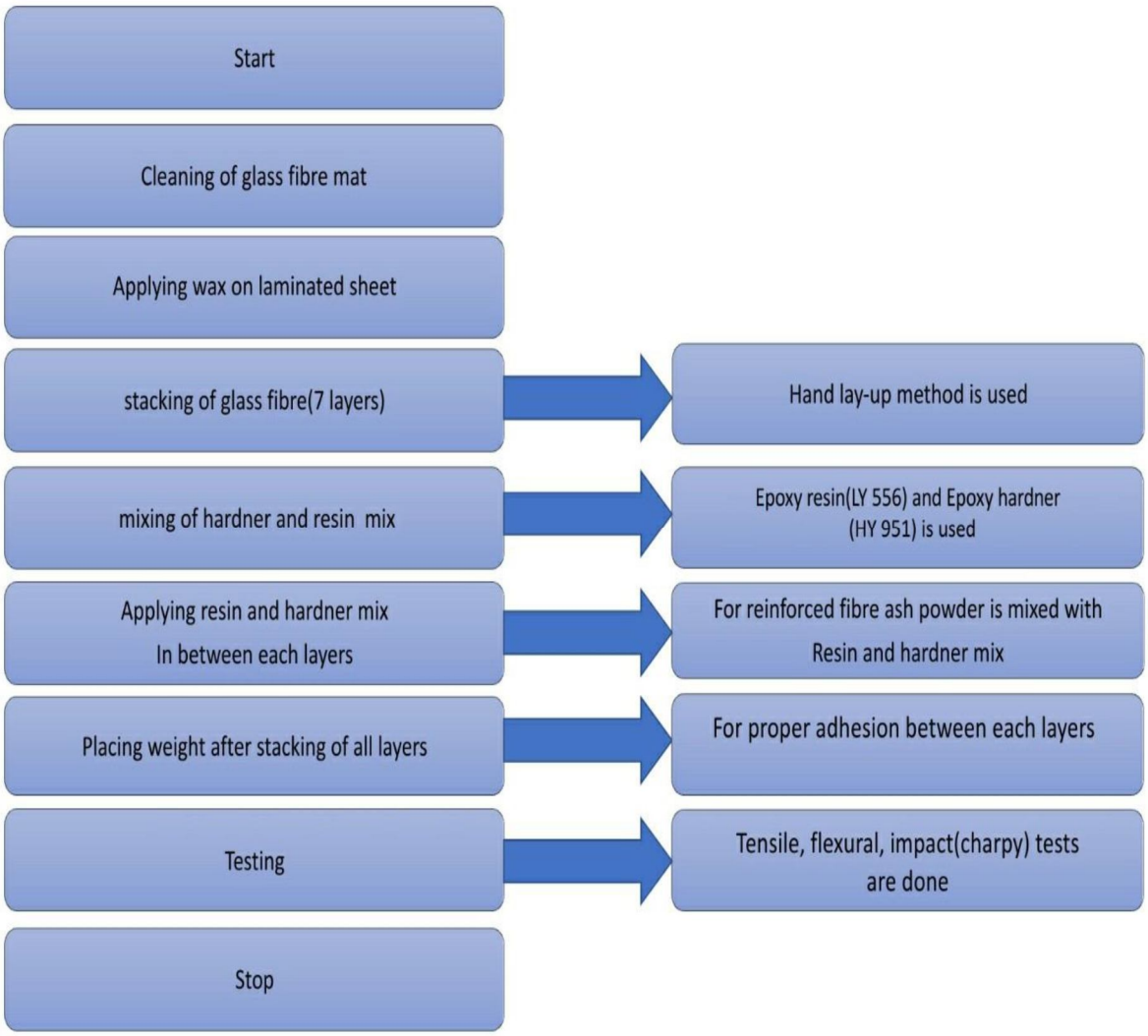
Luca Caracogli and Antonio velazquez "Experimental comparison of the dynamic performance for steel, aluminum and glass-fiber-reinforced-polymer light poles" (2008) observed that, it is conceived as the second part of an experimental analysis and focused on the performance of tapered highway light poles under dynamic excitation. The original motivation coincides with a forensic investigation for the definition of the most plausible collapse cause for aluminum-alloy highway light poles during a wind and winter storm. The comparison of the performances is based on frequency and damping ratios corresponding to first- and second-mode vibration. Experimental testing is employed to derive the dynamic characteristics of the units; moreover, the behavior of a damping device, previously proposed for mitigation of vulnerable units, is analyzed. Previous results, derived for a limited set of cases, are extended in this study to other configurations, including different materials and geometry. Discussion on the derivation of frequency and damping in the presence of closely spaced modes, typical of these systems, is provided. In particular, the effectiveness of several methods for the identification of such quantities is carefully compared.

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Francesco Ascione et.al., "An experimental investigation on the bearing failure load of glass fibre/epoxy laminates" (2008) observed that, This paper deals with an experimental investigation on the bearing failure load of glass fibre/epoxy (GFRP) laminates. The effects of fibre-to-load inclination angle and laminate stacking sequence on the bearing load capacity have been determined experimentally on two different type of laminates: unidirectional and bi-directional (cross-ply). Significant reductions in bearing failure load when fibre inclination angle increases are highlighted. Bearing design formulas are also proposed based on the results of the experiments.

Joakim Schon, "Coefficient of friction for aluminum in contact with a carbon fiber epoxy composite" (2004) observed that, In bolted joints, a large part of the load is transferred by friction. The objective of this investigation is to measure the coefficient of friction for carbon fiber epoxy matrix composite, HTA-6376, in contact with aluminum, 3637-77, in reciprocal sliding. During testing, the coefficient of friction increased initially with number of cycles and after reaching a maximum, slowly decreased. The initial coefficient of friction is approximately 0.23 and the peak coefficient of friction after wear in is approximately 0.68. The coefficient of friction is independent of normal load. During wear, cracks are formed at the fiber–matrix interface, which causes the matrix layer on the original composite surface to break off in pieces. It also causes single fibers or groups of fibers to be broken off and removed from the surface. Pieces of carbon fiber caused depressions in the aluminum surface. The wear debris is reattached to the composite surface but not to the aluminum surface.

III. METHODOLOGY



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IV. MATERIALS AND EXPERIMENTAL METHODS

1) *Epoxy resin (LY-556):* The resin itself is made of biphenyl (and there is more than one type) and epichlorohydrin. The most common type of biphenyl is a combination of acetone and phenol. According to adhesives.org, epoxy resins, when cured, provide "rigid but tough bond lines and have excellent adhesion to metals. Properties of Epoxy Resin (LY-556).Properties of Epoxy Resin (LY-556) as shown in Table 5.1

Table 4.1 Properties of Epoxy Resin (LY-556)

S. No.	Properties	Hardener HY951
1	Aspect (visual)	Clear liquid
2	Viscosity	10–20 mPas (25°C)
3	Density	0.95 g/cm3
4	Flash point	110°C
5	Storage temperature	Room Temperature

2) *Hardener (HY-951):* Hardener is a curing agent for epoxy or fiberglass. Epoxy resin requires a hardener to initiate curing; it is also called as catalyst, the substance that hardens the adhesive when mixed with resin. It is the specific selection and combination of the epoxy and hardener components that determines the final characteristics and suitability of the epoxy coating for given environment.

Table 4.2 Properties of Hardener (HY-951)

S. No.	Properties	Araldite LY556
1	Aspect (visual)	Clear pale-yellowliquid
2	Viscosity	10000–12000 mPa
3	Density	1.3 g/cm3
4	Flash point	>200°C
5	Storage temperature	2–40°C

3) *Prosopis Juliflora:* Prosopis juliflora is a shrub or small tree in the family Fabaceae, a kind of mesquite. It is native to Mexico, South America and the Caribbean. It has become established as an invasive weed in Africa, Asia, Australia and elsewhere. It is a contributing factor to continuing transmission of malaria, especially during dry periods when sugar sources from native plants are largely unavailable to mosquitoes.



Fig 4.1 Natural Fiber of Prosopis Juliflora

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V. RESULTS AND DISCUSSION

From the fabricated composites, the test specimens are prepared as per ASTM standards and are tested to evaluate their tensile, flexural and impact strength. The results by conducting these tests are given below.

A. Tensile Strength

From the above graphs it is observed that, the ultimate tensile strength for GRPF epoxy laminated specimen is 271mpa of the ultimate tensile load of 34.28KN.The ultimate tensile strength for GRPF Epoxy Laminated With Orientation of Prosopis Juliflora Fibre specimen is 329mpa of the ultimate tensile load of 34.23KN.So it is concluded that the ultimate tensile strength of GRPF Epoxy Laminated With Orientation of Prosopis Juliflora Fibre specimen is higher than the GRPF epoxy laminated specimen alone.

Table 5.1 Tensile analysis for GRPF epoxy laminate

Test Parameters	Observed Values
Sample ID	GRPF Epoxy Laminated
Gauge Width(mm)	28.12
Gauge Thickness(mm)	4.50
Original Cross Sectional Area(mm^2)	126.54
Ultimate Tensile Load(KN)	34.28
Ultimate Tensile Strength(Mpa)	271.00

Table 5.2 Tensile analysis for orientation of prosopis juliflora fibre

Test Parameters	Observed Values
Sample ID	GRPF Epoxy Laminated with prosopis juliflora
Gauge Width(mm)	23.12
Gauge Thickness(mm)	4.50
Original Cross Sectional Area(mm^2)	104.04
Ultimate Tensile Load(KN)	34.23
Ultimate Tensile Strength(Mpa)	329.00

B. Flexural Strength

From the above graphs it is observed that, the flexural strength for GRPF epoxy laminated specimen is 8mpa of the flexural load of 1.00KN.The flexural strength for GRPF Epoxy Laminated With Orientation of Prosopis Juliflora Fibre specimen is 24mpa of the flexural load of 2.17KN.So it is concluded that the ultimate flexural strength of GRPF Epoxy Laminated With Orientation of Prosopis Juliflora Fibre specimen is higher than the GRPF epoxy laminated specimen alone.

Table 5.3 Flexural analysis for GRPF epoxy laminate

Test Parameters	Observed Values
Sample ID	GRPF Epoxy Laminated
Gauge Width(mm)	26.58
Gauge Thickness(mm)	4.50
Original Cross Sectional Area(mm^2)	119.61
Ultimate Tensile Load(KN)	1.00
Ultimate Tensile Strength(Mpa)	8.00

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Table 5.4 Tensile analysis for orientation of prosopis juliflora fibre

Test Parameters	Observed Values
Sample ID	GRPF Epoxy Laminated with prosopis juliflora
Gauge Width(mm)	22.65
Gauge Thickness(mm)	4.02
Original Cross Sectional Area(mm^2)	91.05
Ultimate Tensile Load(KN)	2.17
Ultimate Tensile Strength(Mpa)	24.00

C. Impact Strength

It is observed that the impact strength for the GRPF epoxy laminated test specimen has a varying values of 4,6 and 8 joules respectively, which got an average value of 6 joules of absorbed energy. The impact strength for the GRPF Epoxy Laminated With Orientation of Prosopis Juliflora Fibre test specimen has a varying values of 10,12 and 14 joules respectively, which got an average value of 12 joules of absorbed energy. So it is concluded that impact strength for the GRPF Epoxy Laminated With Orientation of Prosopis Juliflora Fibre test specimen is greater than the GRPF epoxy laminated test specimen alone.

Table 5.5 Impact test analysis for GRPF epoxy laminated

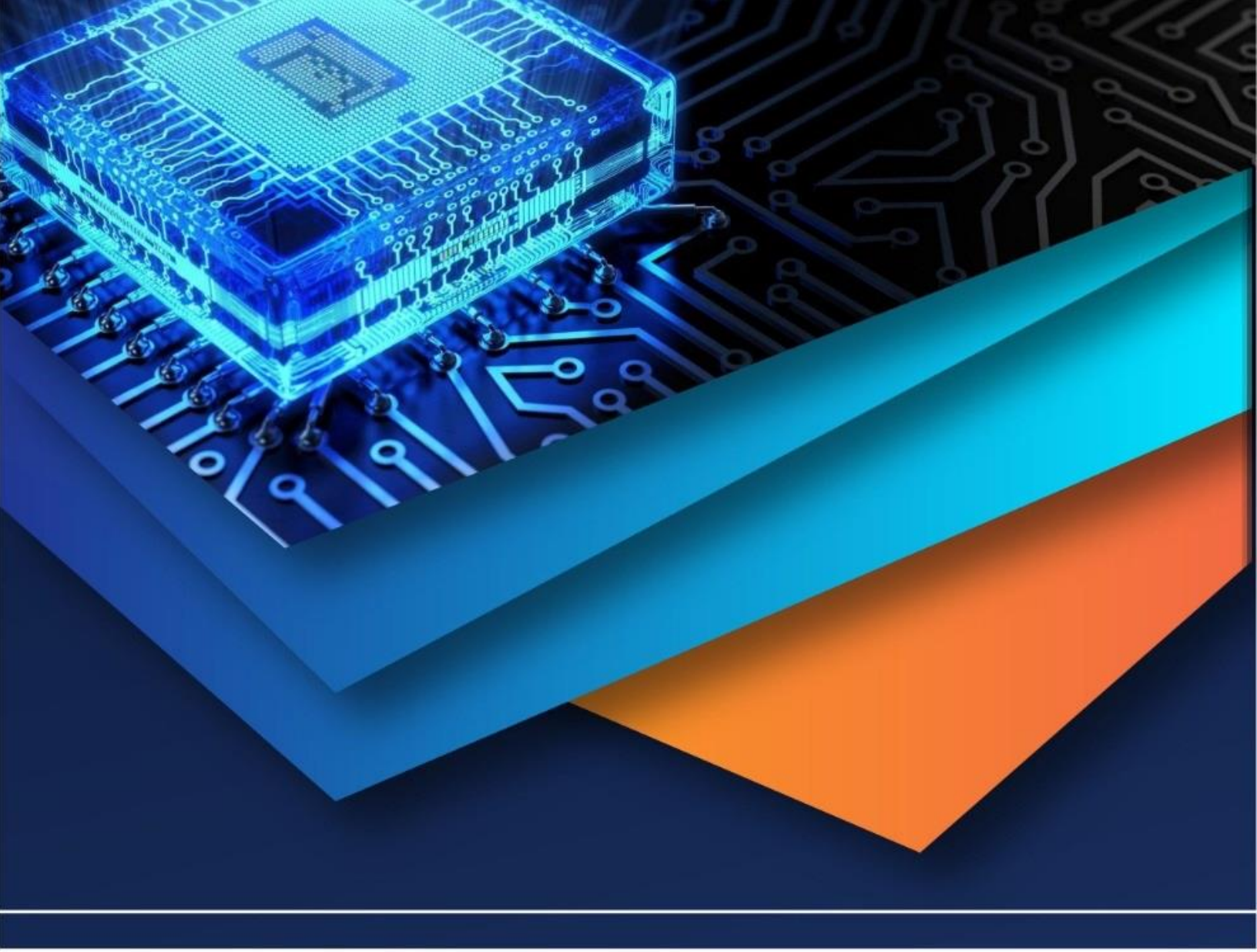
Sample ID	GRPF Epoxy Laminated		
Notch Type	Un Notched		
Test Temperature	24^OC		
specimen size(mm)	4 x 20 x 8		
Absorbed energy (joules)	ID1	ID2	ID3
	04	06	08
Average	6.00		

VI. CONCLUSIONS

From the obtained experimental result, we found that the tensile, flexural and impact strength of the glass fiber with prosopis juliflora is higher than the glass fiber alone. Which may be used for commercial applications.This result will produce the more fusible and dynamic properties in the composite structure. When applying load in flexural strength test the glass fiber with prosopis juliflora specimen was not broken which cause the bending only.So that the elastic property of glass fibre with prosopis juliflora specimen will be high when compared to glass fiber alone. After releasing the load the glass fiber with prosopis juliflora specimen's was tried to regain to original level, which will increase the elastic property of the laminate.so we can conclude that reinforcement of glass fibre with prosopis juliflora can enhance the properties of the composite material when compared to glass fibre alone.

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