

# Development And Characterization Of Curaua Fibers/ Glass Fibers Polyester Composites

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## ABSTRACT

*The curaua fiber is one of the strongest ligno cellulosic and is being currently considered as reinforcement of polymer composite for industrial application. The present work investigates the properties of polyester matrix composites reinforced with continuous curaua fiber and E glass fiber. The developed composites will be tested for tensile, bending, Brinell hardness test and fracture surface will be observed by Scanning Electron Microscope. Polymer matrix composites were developed by hand lay-up technique and specimens were prepared as per ASTM standards.*

**Keywords:** Curaua fiber, glass fiber, polyester, hand layup technique, SEM analysis.

## 1.INTRODUCTION

Among the various available natural fiber in recent times importance is given much to curaua fiber these fibers are extracted from the leaves of pine apple. This curaua fiber is relatively soft; nevertheless it is one of the natural lignocellulosic fibers with potential as polymer composite reinforcement. strength of the fibers increases with increase in cellulose content can be found in curaua fibers. conventional use of these fibers can be found in carpets, ropes etc. these fibers can be used in automobile major reason is these curaua fiber got high impact resistance[1]. The unique microstructure of each curaua fiber consist of group of several micro fibrils bonded together gives the higher impact resistance[3] to the developed composite with glass fiber with polyester resin.

## 2. MATERIALS AND METHODS

Polymer matrix composites were fabricated by hand layup technique for different composition. Normal composite(96% polyester + 4% curaua fiber) and hybrid composite for (94% polyester+3% curaua+3% glass fiber) as per rule of mixture according to ASTM standard for respective tests. Ensure that the desired amount of curaua fiber and glass fiber were placed throughout the mould with additional amount of resin mixed with hardener and catalyst. After curing PMC'S were removed from the mould and prepared according to the ASTM standard in the direction of the fiber aligned.

## 2.1 CURAUA FIBERS

Among the various natural fibers available in Brazil, increased attention is being given to the curaua fibers, particularly in recent times. These fibers are extracted from the leaves of a plant (*Ananas erectifolius*), identified with the family of the pineapple, native of the Amazon region.

The curaua fiber is relatively soft, and it is one of the natural lignocellulosic fibers with potential as polymer composite reinforcement [4]. In addition to their conventional use in nets, blankets and carpets, curaua fiber reinforced composites can also be applied in the automobile industry [2]. Both interior and exterior components and a major reason is the technical advantage of a higher impact resistance. This is of great importance in case of a crash event.



**Fig 1. Curaua fibers extracted from leaves of pineapple**

## 2.2 GLASS FIBERS

Glass fiber has roughly comparable mechanical properties to other fibers such as polymers and carbon fiber. Although not as strong or as rigid as carbon fiber, it is much cheaper and significantly less brittle when used in composites. These glass fibers give better strength to the composite material when used with other natural fibers like curaua [5]. Glass fibers are therefore used as a reinforcing agent for many polymer products; to form a very strong and relatively light weight fiber-reinforced polymer (FRP) composite material called glass-reinforced plastic (GRP), also popularly known as "fiberglass".



**Fig 2. Glass fibers**

## 2.3 POLYESTER RESIN

Polyester is a type of man-made resin. It is a synthetic polymer. With 18% market share of all plastic materials produced, it is third after polyethylene (33.5%) and polypropylene (19.5%). Polyester resin acts as a reinforcement

in this present work. Polyester mixing with hardener and catalyst binds the fiber rigidly with twenty four hour curing time which gives much strength to the composite material.



**Fig 3. Polyester resin**

## 2.4 METHODS

PMC's were developed for normal and hybrid composition using hand layup technique composites were molded by mixing long aligned continuous curaua fiber with mixture of resin, hardener, and catalyst. To ensure that the desired amount of curaua fibers were placed throughout the length and width of the mold, additional amount of polyester resin mixed with the catalyst was added with the fibers. A pressure is applied on the mold during the curing time of 24 hours to facilitate the impregnation of resin through the fibers. After curing, the laminates were prepared in the direction of fibers aligned.



**Fig 5. Polyester 96% 4% curaua fiber specimen**



**Fig 6. Polyester 94%+3% curaua+3% glass fiber specimen**

Fig 5 and 6 show Polyester, curaua, glass fiber composite specimens.

## 3. EXPERIMENTS AND RESULTS

### 3.1 TENSILE TEST

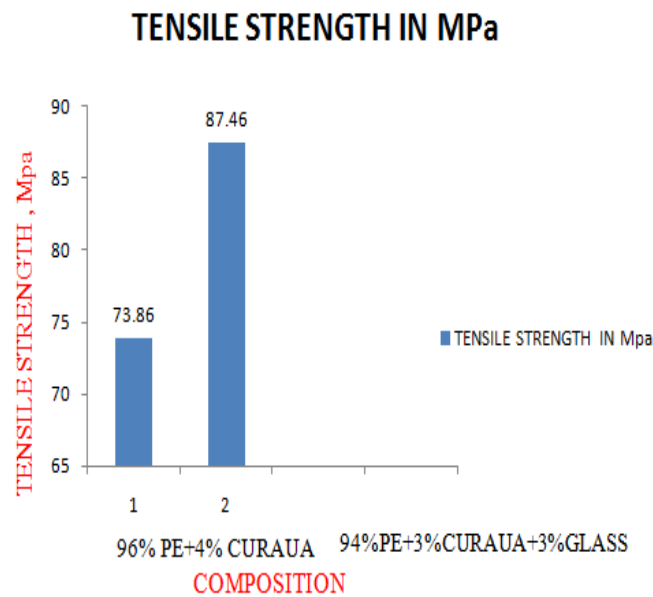
Tensile test is a measurement of the ability of a specimen to withstand loads that tend to pull specimens apart and to what extent the specimen stretches before breaking. The tensile tests were conducted according to ASTM D3039 (250\*25\*3 mm) standard on a Computerized Universal Testing Machine for both set of composition. The fabricated specimens were subjected to tensile test in computerized UTM based on the maximum tensile stress in each specimen tensile strength is calculated using the equation..1.

The values of young modulus (E), Tensile strength obtained from curaua fiber based composites are higher than other natural fibers based composites like coir, bamboo, palm, sisal.[6].

$$Tensile\ Strength\ (MPa) = \frac{Peak\ load\ (P_{max})}{Cross-sectional\ area\ (A)} \dots\dots\dots(1)$$

**Table 1 Ultimate tensile strength results**

Composition	Maximum load	Tensile strength
96% polyester + 4% curaua.	5.54KN	73.86Mpa
94% polyester + 3% curaua + 3% glass	6.56KN	87.73Mpa



**Fig 4. Tensile strength vs. Composition**

From the observation of Tensile test experiment it can be concluded that the composite with 94% polyester + 3% curaua + 3% glass can withstand high tensile strength of 18.41% compared to 96% polyester + 4% curaua.

**3.2 BENDING TEST**

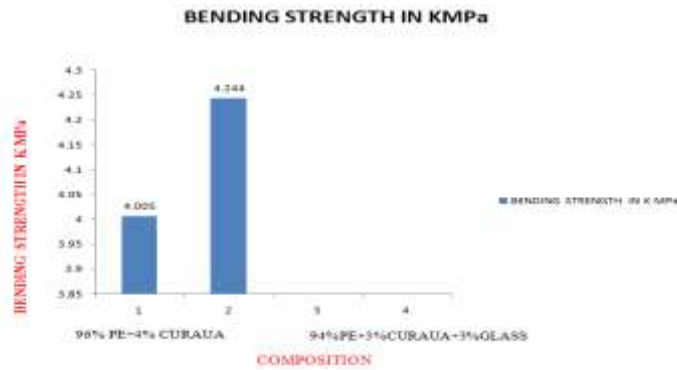
In general bending strength is the ability of the specimen to withstand transverse load applied to the specimen. Basically there are two methods to determine bending strength of a specimen three point bending test and four point bending test.

In this study bending strength of a specimen is determined by three point bending test according to ASTM D790 (62\*12.5\*3) mm for both set of composition. Bending strength decreases with increase in strength to thickness ratio[7], thickness of the specimen should not exceed 3mm. The fabricated specimens were subjected to bending test in instron testing machine based on the maximum load obtained for each specimen bending strength is calculated using equation....2.

$$Flexural\ Strength = \frac{3PL}{2bd^2} \dots\dots\dots(2)$$

**Table 2 Flexural strength results**

Composition	Maximum load	Flexural strength
96% polyester + 4% curaua.	4.36 KN	4.005KN/mm <sup>2</sup>
94% polyester + 3% curaua + 3% glass	4.62 KN	4.244 KN/mm <sup>2</sup> .



**Fig 7. Bending strength vs. Composition**

From the observation of Bending test experiment it can be concluded that the composite with 94% polyester+3% curaua+3% glass can withstand more load of 5.96% compared to 96% polyester + 4% curaua.

**3.3 BRINELL HARDNESS TEST**

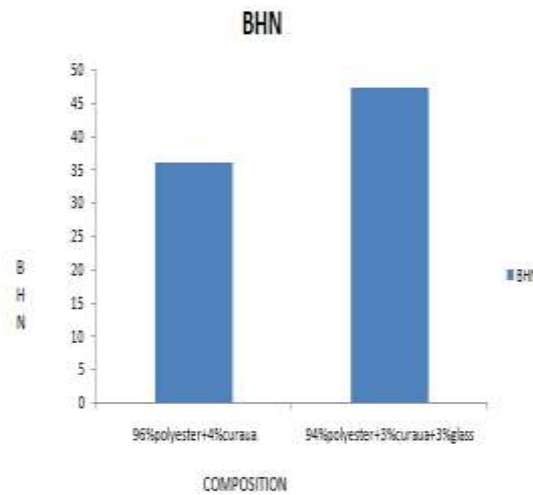
In general hardness test is conducted to determine resistance to indentation of load applied over the specimen for a known duration of time. PMC are always subjected to Brinell hardness test while MMC are always subjected to Rockwell hardness test.

Specimen of size 50\*50\*3 mm is developed for both normal and hybrid composition and subjected to Brinell hardness test .The full load is normally applied for 10 to 15 seconds. The diameter of the indentation left in the test material is measured with a low powered microscope. The Brinell harness number is calculated using equation...3.

$$BHN = \frac{F}{\frac{\pi}{2}D(D - \sqrt{D^2 - Di^2})} \dots \dots \dots (3)$$

**Table.3 BHN results**

Sl. No	Designation of Composites	Diameter of Indentation ( $D_i$ )	BHN in Kg-F/mm <sup>2</sup>
1	96%polyester+4%curaua	1.6	35.99
2	94%polyester+3%curaua+3% glass	2.1	47.22



**Fig 10. Comparison graph for Brinell hardness test**

From the observation of Brinell hardness test experiment it can be concluded that the composite with 94% polyester+3% curaua+3% glass increases hardness by 31.20% compared to 96% polyester + 4% curaua.

**3.4 SEM ANALYSIS**

Micrographic analysis is generally made to study the rupture mechanism of fibers from the fractured surface and to study the bonding behavior of the fibers in hybrid composites [8].



In this present study micrographic analysis is made for the fractured surface of a tensile hybrid specimen.

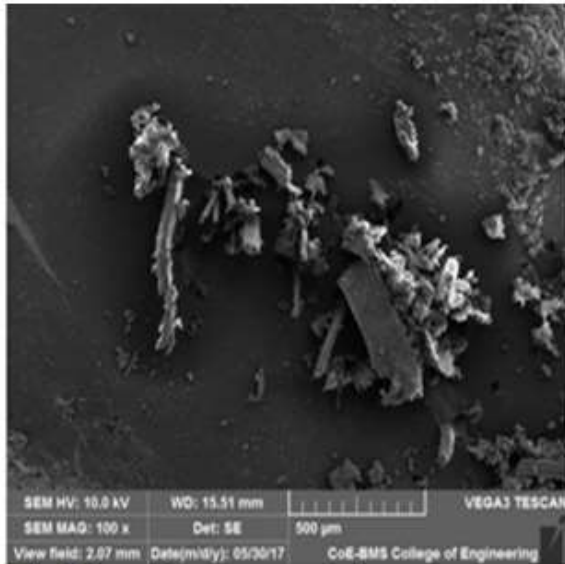


Fig 13. Non uniform rupture mechanism

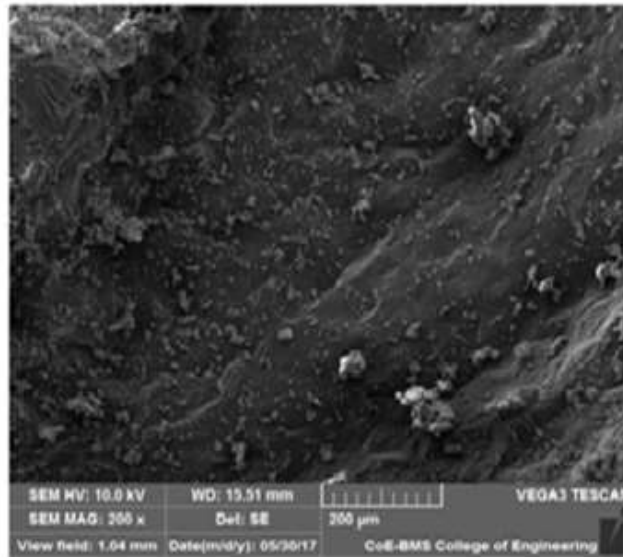


Fig 14. Fiber surface after detached from surface

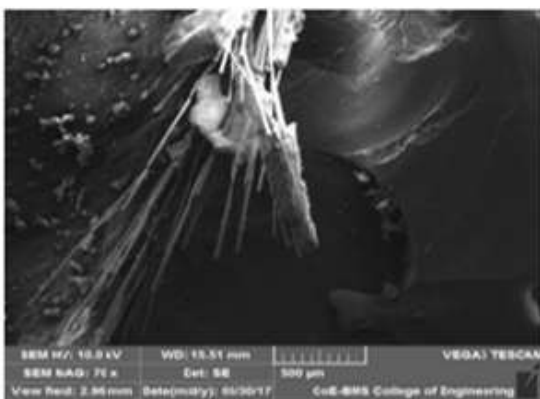


Fig 15. Bonding between curaua and glass

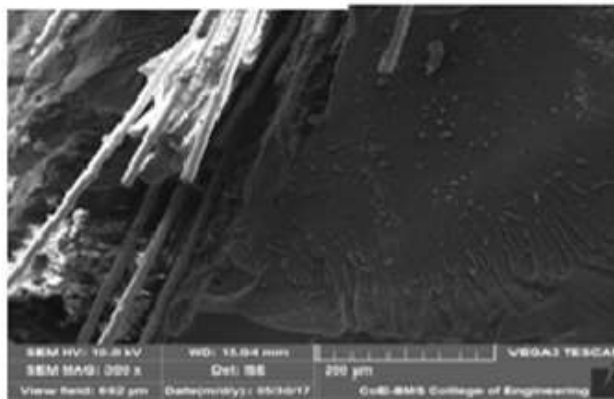


Fig 16. Bonding between curaua and glass

Fig 13 to 16 shows the general aspect of a fractured surface of a tensile hybrid specimen. Fig 12 shows that the fibers tend to rupture from one end few fibers tend to pull out leaving some voids. Fig 13 shows the magnified view of the surface when fibers are detached. Fig 15 and 16 show the bonding between curaua and glass fiber with polyester resin.

#### 4. CONCLUSION

- PMC's have been successfully fabricated by hand layup technique.
- The ultimate tensile strength was found to be increase with the increase in glass fiber content.
- Hybrid composite shows significant increase in bending strength compared to base composite.
- Micro structural evidences indicate that the curaua fiber and glass fiber acts as effective barrier for rupture propagation throughout the hybrid composite. Micro graphs show better bonding between fibrils and resin at the fractured surface of hybrid tensile specimen.
- Micro structural analysis results in the uniform distribution of reinforcement curaua and glass fiber in polyester matrix.

- No fractured surface is observed at the matrix particle interface.

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