



# Fabrication of Areca Composites With Areca Trunk Husk in Araldite LY556 and Polyester Iso Resins and Evaluation of Their Mechanical Properties

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**Abstract:** In contrast with the past natural fibers derived from renewable resources have the potential to replace glass, carbon, and other man-made fibers in polymer composites as a reinforcing material. The research emphasis is on the study of areca fiber and areca trunk husk with Araldite LY556 epoxy resin with hardener HY-951 in a 10:1 ratio and polyester Iso resin with hardeners accelerator and catalyst. where for 1 kilogram of polyester iso resin 20 grams of accelerator and 15 grams of catalyst should be taken for the complete composition of fiber materials. Four laminated sheets are fabricated according to ASTM standards. Two different laminate sheets are fabricated in which two contain areca trunk husk in their resin and the other two do not contain in its resin. This fabrication process is done by using the hand layup process and the press molding process. The mechanical properties of laminated sheets are tested by conducting compression, tensile, impact, and hardness tests. Laminates with optimal mechanical properties are suggested for future applications.

**Keywords:** Areca trunk husk, Mechanical properties, Hand layup process

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## INTRODUCTION:

Natural fiber-reinforced composites have been the subject of steadily growing research over the past ten years due to their potential to replace synthetic fiber-reinforced plastics in various technical applications and industries at a lower cost with greater sustainability [1-3]. The development of diverse polymer matrix composites with a variety of fiber reinforcements, including carbon fiber, glass fiber, aramid, natural fibers, hybrid, etc. was stimulated by the requirement for a high strength-to-weight ratio in components that demanded great performance and efficiency. Natural fiber composites play a significant role when it comes to the use of environmentally friendly materials and the requirement to create diverse sustainably oriented engineering and industrial components [3-4].

Hand lay-up, which dates back the longest, is the method used to make woven composites. Following certain protocols, the samples are prepared. The surface is initially treated with release antiadhesive to stop the polymer from sticking to the mold surface [5]. A thin plastic sheet is then placed over the mould plate at the top and bottom to provide a level surface for the completed product. The woven reinforcing layers are spread down on the surface of the mold and cut into the required shapes. As a consequence, as already said the resin was blended with other components and infused onto the surface of the reinforcement that was already assembled in the mold. Following that, the remaining mats are positioned on top of the previous polymer layer, and pressure is applied with a roller to get rid of any trapped air bubbles and additional polymer. After that, the mould is sealed and the pressure is released to create a single mat. Once room-temperature curing is complete, the woven composite is removed from the molded surface [6].

Areca fruit, fronds, and stem leaves are the main sources of areca fiber. With non-reversible polymers in particular, the world nowadays is challenged with the dilemma of developing new and propelled technologies and techniques to eliminate or utilize solid wastes. The techniques used to separate the wastes aren't cost-effective and often produce dangerous substances [7]. Given these considerations, it appears that the only solution to the problem is to reinforce polymers with natural fibers. Normal strands are less thick, readily available, reusable, and environmentally beneficial. They can be used to replace conventional strands because they have great tensile qualities. Using characteristic strands to strengthen plastics has the significant drawback of creating a weak link between regular filaments and lattice gums, which results in less flexible properties [8].

### **LITERATURE REVIEW:**

Dr.S. Yamuna Devi's et al. [1] researchers and scientists are anticipating fiber sources for sustainable processing. The ultimate objective is to create an organic fiber that may be used in the textile industry and to create environmentally friendly products. L(sheath), which has drawn attention on a global scale as a hazard to biodiversity. The physical, chemical and structural characterization of the fiber obtained from Areca catechu is thus highlighted in this work. By using manual combing in addition to conventional water retting, fibers were recovered. The sample's mechanical and physicochemical characteristics were investigated. In terms of strength and rigidity, fiber demonstrated the best mechanical qualities; however, they were less extensible.

C.V. Srinivasa, K.N. Bharath et al. [2] In the current study, the mechanical characteristics of composites made of natural fibers were assessed. Areca fiber is used in this instance as a new natural fiber reinforcement, while epoxy resin serves as the matrix. Chemical processing was used to improve the interfacial interaction between the matrix and the areca fibers that were isolated from the husk. impact and hardness tests were carried out mechanically, and the results are presented. When compared to naturally occurring, untreated fibers, the mechanical characteristics of composites made of chemically treated areca fibers perform better. It is also important to note that the strength of areca fiber composites resins with an increase in the volume percentage of fiber in the composite and post-composites curing time.

G. C. Mohan Kumar et al. [3] studies that the areca fibers mechanical characteristics are identified and contrasted with those of other natural fiber coins that are currently available. Also, these Areca fibers underwent chemical treatment, and their impact on fiber strength is investigated. Using randomly positioned fibers in maize stalk fine fiber and phenol formaldehyde, areca fiber composite laminates were created. To evaluate the impact of the biodegradable test on the strength of PF composites, chemical changes of fibers through alkali treatment were conducted. Most of the microvascular tubules have fractured at once, as shown in the EMS image of the fracture surface, and they exhibit brittle behaviour. Areca fibers that have been alkali-treated and have tensile strengths that are greater than a natural fiber, reaching a maximum of 123.36 MPa. Maize fiber has a 152MPa strength which is more than areca fiber. According to what is described in the section, the alkaline treatment of maize fibers favourably enhances the fiber surface.

E. Devaki, K. Sangeetha et al. [4] In the present study, the Areca nut fruit is retted with water that is either stagnant, flowing, or salty for a period of five days to explore the effects of the retting procedure and pre-treatments on the fiber surface by SEM examination. It must be dried for 2 to 3 days in the shade after 5 days. Areca nuts were thoroughly dried before the fiber was hand removed and treated with an alkali and an enzyme. The fiber's composition, characteristics, and SEM (scanning electron microscope) pictures of both enzyme- and untreated fiber were studied. With the use of SEM analysis, it is demonstrated that the retting procedure and the treatments applied to the fiber alter the surface morphology. When untreated fibers were compared to untreated fibers in the burning test, the ash and colour were altered.

Dr. Ramu Murugana, Dr. Sathishkumar Jothi et al [5] This study examines the mechanical performance of an epoxy composite reinforced with natural areca fiber in a variety of configurations. The composite with the sheath fiber orientation of 90°-90°-90° had the maximum strength, and its estimated Young's modulus was 1.798GPa. Composites with other sheath fiber orientations were constructed, and a

tensile test was conducted. The composite's maximal elongation before the specimen's first failure was calculated. The composite that elongated to around 11.6% of its initial length contained sheath fibers oriented 90°, 90°, and 90°. The benefit of the composite with fibers oriented 90°, 90°, and 90° was that it could tolerate more strength when the force was simply applied in the sample's longitudinal direction.

R. H. Desai; Dr. L. Krishnamurthy and Dr. T.N. Shridhar et al. [7] The primary objective of this research is to investigate the density, impact strength, hardness, and dielectric properties of a polypropylene areca fiber composite reinforced with random distribution and varying areca fiber loading. The findings show that polypropylene areca fiber composites' improved characteristics over plain polypropylene growth with fiber loading. Using the extrusion method, this study has effectively produced polypropylene reinforced with areca fibers with various fiber loading fractions, and test samples have been generated using the injection molding method. It may conclude that composites strengthened with areca fibers are promising new materials with increased strength for use in commercial, residential, and automotive applications.

### **PREPARATION OF LAMINATED SHEETS**

The composite materials used in the current investigation are the areca fiber cloth mat and areca trunk husk. A total of four laminated sheets are prepared for this research. Two different resins are used to form these laminate sheets. Two laminate sheets are prepared by using Araldite L556 as resin and HY951 as a hardener. The other two laminate sheets are prepared using polyester Iso resin, accelerator, and catalyst as hardeners.

Laminates are prepared by using Araldite L556 as resin and HY951 as hardener:

Two areca laminated sheets using Araldite L556 with hardener HY951 are prepared. These laminates were prepared by taking the resin–hardener ratio as 10:1. One of these laminates was prepared by mixing the areca trunk husk in the resin. The second laminate does not contain the areca trunk husk.

Araldite L556 – HY951 laminated sheet (with areca trunk husk):

The current study's composite materials include an areca fiber cloth mat and an areca trunk husk. In this laminate the areca trunk husk is added to the Araldite L556 resin – HY951 hardener composition. A hand layup process is used to prepare these laminates. To prevent the composite mat from bonding to the surface, a thin PVC transparent film sheet is utilized at the mold's apex and base. Five layers of areca cloth fibers are placed on top of one another with the resin mixture applied between each layer. The weight of the areca cloth mat is 64 grams. Since the weight of the resin should be three times more than the weight of the mat as per standard. 192 grams of resin including 10 grams of areca trunk husk is taken to produce these laminates. Rubber wipers are utilized to avoid air bubbles on the mat's surface.

Araldite L556 – HY951 laminated sheet (without areca trunk husk):

This laminate is produced by using the same process as laminated sheets with areca trunk husk. However, this laminate sheet does not contain areca trunk husk in its resin mixture. These mats have been left for up to 24 hours in the sunlight to harden. Each mat is split into two laminates after hardening by ASTM specifications for tensile, compression, impact, and hardness testing.

Laminates are prepared by using Polyester Iso resin and Accelerator, catalyst as hardener:

Two areca laminated sheets using polyester Iso resin with hardener (accelerator, catalyst) are prepared. For 1 kilogram of polyester resin, 20 grams of accelerator and 15 grams of catalyst should be taken for the complete composition of fiber materials. One of these laminates was prepared by mixing the areca trunk husk in the resin. The second laminate does not contain the areca trunk husk

Polyester Iso resin with hardener as the accelerator, and catalyst (with areca trunk husk):

The current study's composite materials include an areca fiber cloth mat and an areca trunk husk. In this laminate, the areca trunk husk is added to the Polyester-accelerator and catalyst hardener composition. A hand layup process is used to prepare these laminates. To prevent the composite mat from bonding to the surface, a thin PVC clear film sheet is used at the top and bottom of the mold. Five layers of areca cloth fibers are placed on top of one another with the resin mixture applied between each layer. The weight of the areca cloth mat is 64 grams. Since the weight of the resin should be three times more than the weight of the mat as per standard. 192 grams of resin including 10 grams of areca trunk husk is taken to produce these laminates. Rubber wipers are utilized to avoid air bubbles on the mat's surface.

Polyester Iso resin with hardener as the accelerator, and catalyst (without areca trunk husk):

This laminate is produced by using the same process as laminated sheets with areca trunk husk. However, this laminate sheet does not contain areca trunk husk in its resin mixture. These mats have been left for up to 24 hours in the sunlight to harden. Each mat is split into two laminates after hardening by ASTM specifications for tensile, compression, impact, and hardness testing.



Fig-1 Preparation of laminates by using Araldite L556, Polyester, and Areca trunk husk

Table-1 Laminates composition

| Laminates | Laminated Sheets Composition | Areca Mat (AM) |       | Areca Trunk Husk In Resins (AH) | Araldite L556 (A.L556) | Polyester Iso Resin (PR) |
|-----------|------------------------------|----------------|-------|---------------------------------|------------------------|--------------------------|
|           |                              | No. of layers  | In gm | In gm                           | In gm                  | In gm                    |
| L1        | AM+AH+A.L556                 | 5              | 64    | 10                              | 192                    | 0                        |
| L2        | AM+A.L556                    | 5              | 64    | 0                               | 192                    | 0                        |

|    |          |   |    |    |   |     |
|----|----------|---|----|----|---|-----|
| L3 | AM+AH+PR | 5 | 64 | 10 | 0 | 192 |
| L4 | AM+PR    | 5 | 64 | 0  | 0 | 192 |



Fig-1.1 L1



Fig-1.2 L2



Fig-1.3 L3



Fig-1.4 L4

## RESULTS AND DISCUSSIONS:

After the preparation of laminates, they are tested using a universal testing machine (UTM) to examine their compression and tensile properties. The impact and hardness tests are conducted using Charpy and Rockwell hardness testing machines. The results obtained from these tests are discussed below.

### Compression test:

The force which is responsible for the deformation of the laminate refers to the compressive tests. All laminates were subjected to a compression test using a fixture that was based on the ASTM D695 standard. The compressive qualities of specimens S-1, S-2, S-3, and S-4 were tested using a UTM machine in line with the ASTM standard. The test specimen has a size of (200 x 20mm). During the test, Uni-axial stress is delivered through both ends of the specimen until it fractures. Table 2 displays these outcomes

Table-2 Compression Test Results

| Specimens | Maximum Load (N) | Compressive Strength (Mpa) | Compressive Strain (mm/mm) | Compressive Modulus (Gpa) | Extension At Max Compressive Load (mm) |
|-----------|------------------|----------------------------|----------------------------|---------------------------|--|
| S1        | 2417.96          | 5.34                       | 0.00796                    | 1240.35906                | -2.29223                               |
| S2        | 1899.38          | 4.20                       | 0.00659                    | 1236.17141                | -2.31152                               |
| S3        | 874.17           | 1.93                       | 0.00814                    | 346.97219                 | -5.21187                               |

|    |         |      |         |            |          |
|----|---------|------|---------|------------|----------|
| S4 | 1783.52 | 3.94 | 0.00549 | 1326.01151 | -1.92275 |
|----|---------|------|---------|------------|----------|

According to Fig 2. The braking area is situated in the middle of the specimen. Fig 2.1. shows the specimen that is shattered. The stress-strain raw data used to calculate the compressive strength and compressive modulus of various specimens is represented by specimen graphs in Fig 2.2. The results shown in Table-2 indicate that Araldite L556 – HY951 specimen pieces (with areca trunk husk) can withstand the maximum load, maximum compressive strength, and maximum compressive modulus than the Araldite L556 – HY951 specimen pieces (without areca trunk husk). Specimen piece S1 (AM+AH+A.L556) is better than specimen piece S2 (AM+A.L556). The same process is done by using polyester iso resin then the results are obtained by using Polyester Iso resin with hardener as the accelerator, and catalyst (with areca trunk husk). The specimen piece S3 (AM+AH+PR) has less maximum load, maximum compressive strength, and maximum compressive modulus than the specimen piece S4 (AM+PR) Polyester Iso resin with hardener as the accelerator, and catalyst (without areca trunk husk).



Fig-2 compression test of the specimens Fig-2.1 specimens after Compression Test

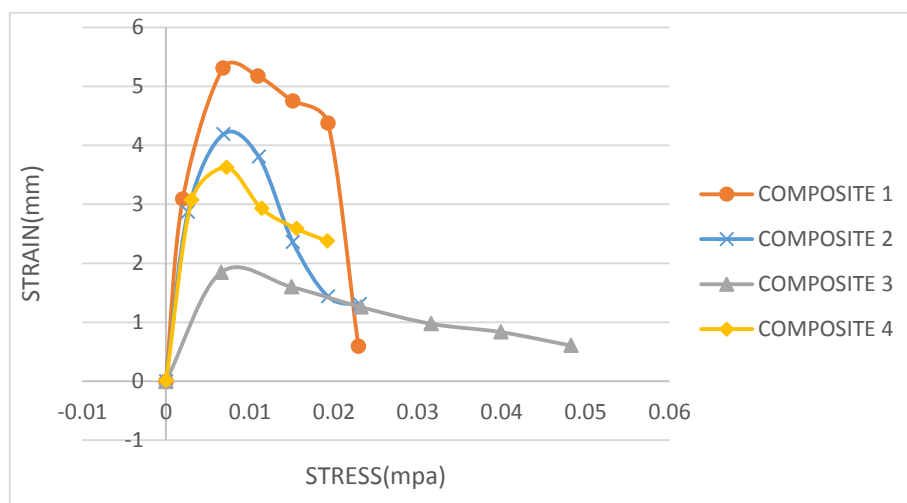


Fig-2.2 stress vs strain graph for compression test



**Tensile strength:**

As demonstrated in fig. 3, it measures the amount of force required to break a composite as well as how much stretching or elongation must occur before the specimen breaks. Tensile characteristics of specimens S-1, S-2, S-3, and S-4 were examined by the ASTM D3039 standard using a UTM machine. The size of the test sample is (200 x 25 mm). The specimen is subjected to a uni-axial load through both ends of the test until it cracks, as shown in fig. Following the result analysis, the ultimate tensile strength of the composite laminates is determined.

Table-3 Tensile Test Results

| Specimens | Maximum load (N) | Ultimate Tensile Strength (MPA) | Tensile Strain (mm/mm) | Tensile Modulus (Gpa) | Elongation (mm) |
|-----------|------------------|---------------------------------|------------------------|-----------------------|-----------------|
| S1        | 4131.65          | 65.58                           | 0.01482                | 6238.64530            | 1.78            |
| S2        | 1374.86          | 21.82                           | 0.02440                | 1368.94120            | 2.95            |
| S3        | 3231.51          | 51.29                           | 0.01203                | 5779.02193            | 1.44            |
| S4        | 5155.72          | 81.84                           | 0.02293                | 4601.23326            | 2.76            |

Using stress-strain raw data, the specimen graphs in Fig-3.2 demonstrates estimated the tensile strength and tensile modulus of different specimens. The tested specimens got deformed in their shape shown below in fig 3.1. The results show that the Araldite L556 – HY951 specimen piece (with areca trunk husk) can withstand the maximum load, maximum tensile strength, and maximum tensile modulus than the Araldite L556 – HY951 specimen piece (without areca trunk husk). Specimen piece S1 (AM+AH+A.L556) is better than specimen piece S2 (AM+A.L556). The same process is done by using the polyester iso resin then the results are obtained by using Polyester Iso resin with hardener as the accelerator, and catalyst (with areca trunk husk). The specimen piece S3 (AM+AH+PR) has less maximum load, maximum tensile strength, and maximum tensile modulus than the specimen S4 (AM+PR) Polyester Iso resin with hardener as the accelerator, and catalyst (without areca trunk husk).



Fig-3 Tensile test of the specimens using UTM

Fig-3.1 specimens after Tensile Test

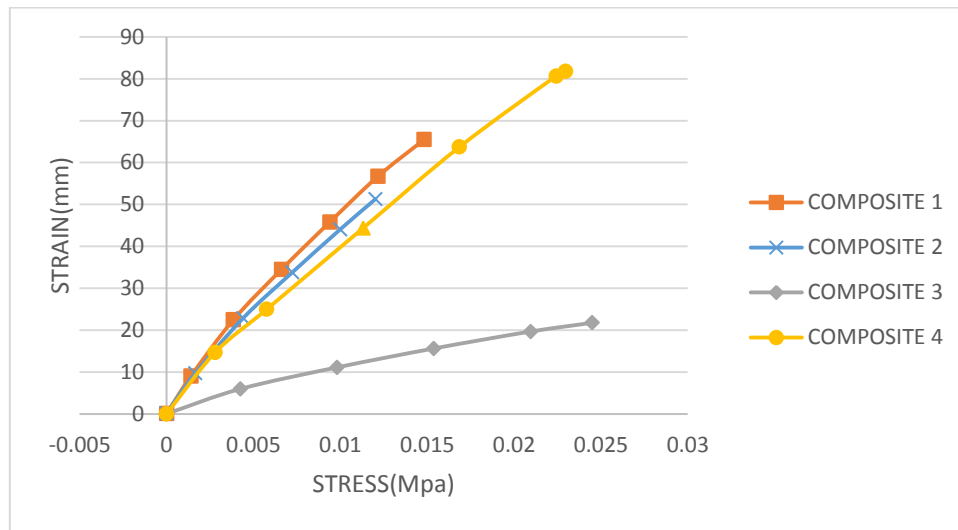


Fig-3.2 stress vs strain graph for tensile test

Compression And Tensile Test Load Graph:

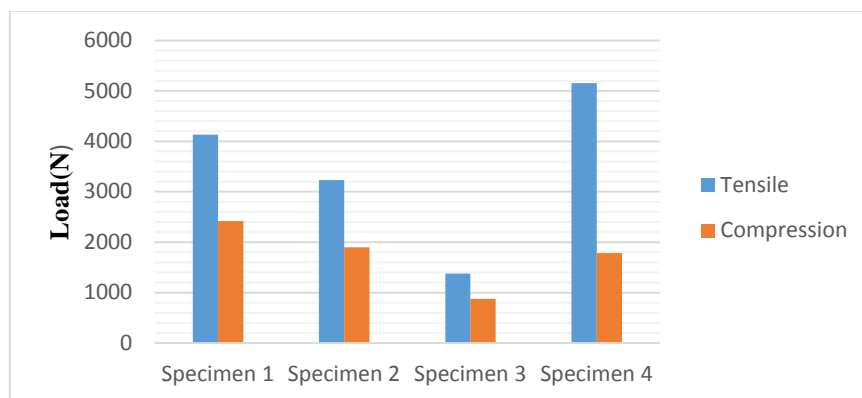


Fig-4 load graph

The raw data is used to plot the load graph after the laminates have undergone mechanical testing, as illustrated in fig 4. The above load graph shows that the laminate which is prepared by using Araldite L556 as resin and HY951 as a hardener (with areca trunk husk) has more compression and tensile load than the laminate prepared without areca trunk husk. The laminate is prepared by using Polyester Iso resin and Accelerator, catalyst as hardener Polyester Iso resin and Accelerator, catalyst as a hardener (with areca trunk husk) has less compressive and tensile load than the laminate prepared without areca trunk husk.

### Hardness test:

According to the net increase in depth of imprint as a force is applied, the Rockwell Hardness test gauges hardness. Many times, the R, L, M, E, and K scales express hardness numbers without units. Higher numbers indicate a material's hardness.

Using a hardness testing device by the ASTM D785 standard, the hardness of laminates S-1, S-2, S-3, and S-4 was assessed. The dimensions of the test sample are (30 x 30 mm). A reference sample is set on top of the Rockwell Hardness tester. The gauge is reset to zero in the wake of a light load. The principal load is imposed by pulling a lever. After 15 seconds the lift is completed. The hardness is assessed while still providing light stress after giving the specimen 15 seconds to recuperate.



Table-4 Hardness Test Results

| S.no | Specimens | Hardness number |
|------|-----------|-----------------|
| 1    | S1        | 56.30           |
| 2    | S2        | 53.30           |
| 3    | S3        | 54.07           |
| 4    | S4        | 56.33           |

As shown in table 4 the specimen piece which is prepared by using Araldite L556 as resin and HY951 as a hardener (with areca trunk husk) has more Hardness bearing strength than the specimen piece prepared without areca trunk husk. The specimen piece which is prepared by using Polyester Iso resin and Accelerator, catalyst as hardener Polyester Iso resin and Accelerator, catalyst as a hardener (with areca trunk husk) has less hardness bearing strength than the specimen piece without areca trunk husk. Fig 5 shows the specimens after the hardness test.



Fig-5 Specimens after Hardness Test



Fig-5.1 Hardness Test using Rockwell Machine

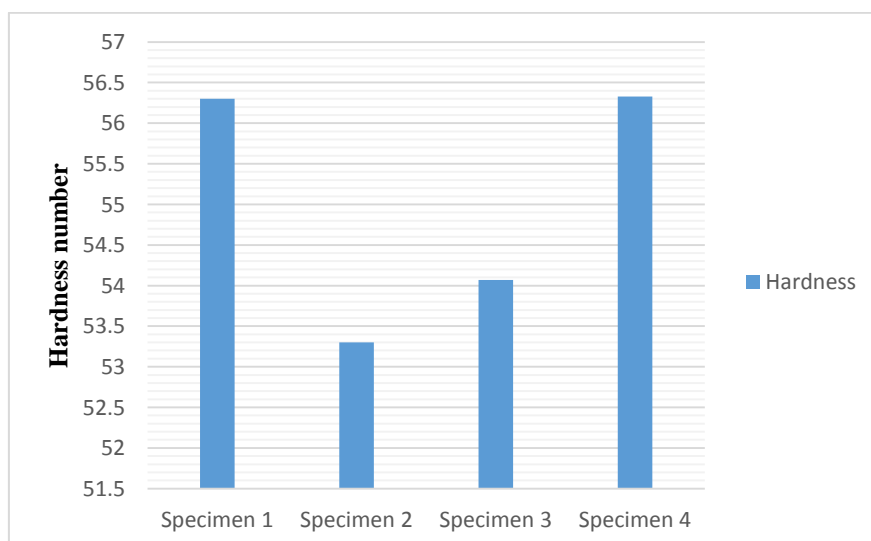


Fig-5 Hardness test bar graph

**Impact Test:**

A pendulum hammer is discharged from a standard height to strike a beam specimen (either notched or unnotched) with a specific amount of kinetic energy during Charpy and Izod impact tests. The Charpy test is used for the specimens. The rectangular specimen with a notch cut out of one side fits into the Charpy impact tester. The notch permits the fracture to start at a predefined place.

Using impact testing equipment by ASTM A370 standard, the impact characteristics of the specimens S-1, S-2, S-3, and S4 were examined. Test sample dimensions are (55 x 13 mm). Impact testing is a method for calculating the energy that a material absorbs during fracture. The effectiveness of a certain material is assessed using this method. The impact resistance of the composite laminates is calculated after the result analysis.

Table-5 Impact test results

| S.no | Specimens | Impact strength(J) |
|------|-----------|--------------------|
| 1    | S1        | 80                 |
| 2    | S2        | 54                 |
| 3    | S3        | 58                 |
| 4    | S4        | 70                 |

As shown in table 5 the specimens which are prepared by using Araldite L556 as resin and HY951 as a hardener (with areca trunk husk) have more impact strength than the specimen piece prepared without areca trunk hunk. The specimen piece which is prepared by using Polyester Iso resin and Accelerator, catalyst as hardener Polyester Iso resin and Accelerator, catalyst as a hardener (with areca trunk husk) has less impact strength than the specimen piece prepared without areca trunk hunk. Fig 6 and Fig 6.1 The specimens are seen both before and after the impact test.

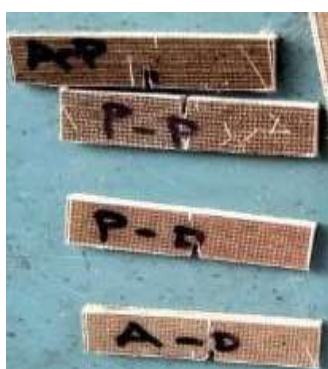


Fig-6 Specimens before impact test



Fig-6.1 Specimens after impact test

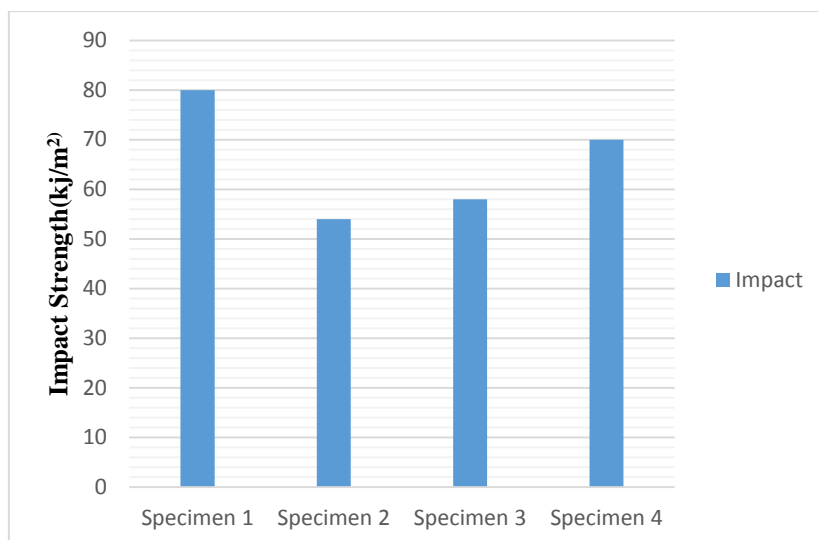


Fig-6.2 Impact test bar graph

## CONCLUSION:

In this research, two laminates are prepared by using Araldite L556 as resin and HY951 as a hardener, and the two Laminates are prepared by using Polyester Iso resin and Accelerator, catalyst as a hardener with areca trunk husk in resins done by using a hand lay-up process. The mechanical properties gathered from the laminated sheets are shown.

- While comparing the laminates prepared by Araldite L556 – HY951 laminated sheet (with areca trunk husk) has more compression, tensile, hardness, and impact strength than the laminate prepared without areca husk.
- In the same way, the Laminates are prepared by using Polyester Iso resin and Accelerator, catalyst as a hardener (without areca trunk husk) has more compression, tensile, hardness, and impact strength than the laminate prepared with areca husk.
- From the above research, the laminates prepared by using Araldite L556 (with areca trunk husk) and laminates prepared by using Polyester Iso resin (without areca trunk husk) are suggested due to better mechanical properties.

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