Investigation on the Mechanical Characteristics of Bio-Composites Derived from Jute, Palm Fibers and Seashell Powder

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ABSTRACT

In the present investigation, the polymer based bio-composite laminates reinforced with jute, palm fiber mats, and sea shell powder are prepared and tested for mechanical characterization. The Hand-lay-up and press molding methods are used to fabricate polymer composite laminates. An epoxy (LY556) and hardener (araldite) (HY951) are combined in accordance with ASTM standards. Epoxy and hardener have a 10:1 ratio before being utilized to make laminates; the material will be thoroughly mixed for some time. After that Jute fiber, palm fiber, and sea shell powder were used to create different sample compositions. The mechanical properties of the laminate were investigated using tests for impact strength and hardness. The mechanical characteristics of palm and jute fibers are increased, accordingly by adding sea shell powder.

Keywords: Epoxy, Hand layup, Composite laminates, Impact strength, Hardness.

1. Introduction

Natural fiber composites are now increasing in popularity due to their environmental advantages. Natural fibers, such as jute and palm fiber, are cheap, abundant, and renewable. They are also lightweight, low density, extremely durable, and biodegradable. For applications needing high strength to weight ratios further weight reduction in composites, natural fibers like jute and palm could be used in instead of traditional reinforcement materials. P.V.Sanjeeva Kumar et al., [1-3] were focused their investigations on polymer based composites to pursue its mechanical characteristics. A composite is a mixture of two materials, one of which is the reinforcing phase and takes the form of fibers, layers, or powders. Alderliesten et al., [4] conducted study on damage tolerance and fatigue issues of GLARE in aircraft assemblies Sandwich composites are rate effective obligating properties such as excessive formability, extraordinary strength to low weight ratio and clash to damping are in great demand for frequent applications. Volta et al., [5] studied of towards application of fiber-metal laminates in large aircraft. The use of composite by marketable aircraft corporations in key structural components are growing ominously with the advent of composite sections and wings. Sinmazçelik et al., [6] reviewed of background, fiber metal laminates, bonding varieties and applied test approaches composite materials have been topic of perpetual attention of various authorities during the last years. Botelho et al., [7] reviewed on the development and properties of continuous fiber/aluminum/epoxy hybrid composites for aircraft constructions. Kim KJ et al., [8] in Development of application technique of aluminum sandwich sheets for automotive hood Progress of application technique of aluminum sandwich sheets for automotive hood Objective of this revision was to develop elementary techniques in order to relate aluminum sandwich sheets for an automotive hood part. Raj Kumar et al.,[9] in Investigation of repetitive low velocity impact performance of GFRP/aluminum and CFRP/aluminum laminates The objective of this study was to investigate response of repeated small velocity impact tests on glass fiber/ epoxy-Al metal laminates (GEAML) and carbon fiber/ epoxy-Al metal laminates (CEAML) at the similar location by drop-weight tester. CEAML, GEAML as fine as monolithic Al panels of the similar thickness remained impacted repeatedly up to four impacts. Sexton et al., [10] in European Conference on Composite Materials the drop in the weight of vehicles is an essential component for falling demand for non-renewable resources and the greenhouse gas emissions associated with the use of vehicles. Tzetzis et al., [11] in drawing behavior of metal composite sandwich structures Fiber-metal laminates (FMLs) with dissimilar fiber-reinforced composites using finite element analysis. Sugun BS et al., [12] in Cost actual approach for the manufacture of fiber metal laminates (FML Fiber metal laminates are super composite materials combining several properties of fiber and metal layers that constitute them and having potential applications in engineering industry and universal purpose industrial applications. Various investigation were carried on the polymer based composites in order to investigate their mechanical properties [13-16].

2. Materials and Methodology

In the present work for fabricating the composite materials, main constituent is an epoxy and the reinforcement is included as jute, palm fibers, and sea shell powder. The laminate plates were produced by mixing epoxy resin LY556 and hardener HY951 in a ratio of 1:10. The manual hand layup procedure is used for making the composite laminates and is shown in Fig. 2.1. The different composite laminate plates are made with different compositions and the details are given in table 2.1.

Fig-2.1 preparation of laminates

Table-2.1 Composition of laminates

S. No	Laminates	Palm fiber		Jute fiber		Sea-shell powder in resin	Epoxy resin
		Number of layers	In grams	Number of layers	In grams	In grams	In grams
1	P-P-P-P	4	36	0	0	0	108
2	P-J-P-J	2	18	2	21.5	0	120
3	J-J-J-J	0	0	4	43	0	129
4	P-J-J-P	2	18	2	21.5	5	120
5	J-P-J-P	2	18	2	21.5	10	120

To prevent the composite mat from bonding to the surface, a thin PVC clear film sheet is used as cover sheet at the top and bottom of the mould in order to free release of solidified composite plates. The Hand layup technique is used to prepare five composite mats. To avoid air bubbles on the mat's surface, rubber wipers are utilized. These mats have been let up to 24 hours in the sunlight to harden. Each mat is split in two laminates after hardening in accordance with ASTM specifications to prepare the specimens for impact and hardness testing.

3. Results and Discussions

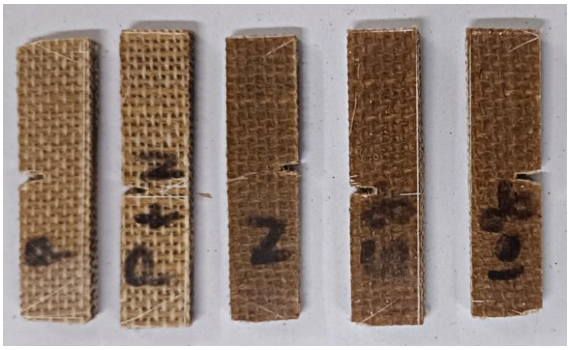
3.1 Impact Test

The impact characteristics of the laminates L-1, L-2, L-3, L-4, and L-5 were tested in accordance with the ASTM A370 standard using an impact testing equipment. The size of the test sample is (55mm x 13 mm). The energy that a material absorbs during fracture is calculated using an impact test. It is used to determine how effect a given material under impact loads. The impact strength of the all five specimens is determined and the test results are tabulated in table 3.1.

Table 3.1: Impact test results

S. No	Laminates	Impact Strength(kJ/m^2)
1	L1	50
2	L2	52
3	L3	52
4	L4	48
5	L5	54

The images of tested sample laminates before testing and after testing are shown in Fig. 3.1 and Fig 3.2 respectively. The impact strength of different laminates is shown in Fig 3.3 and from it is observed that the laminate-5 gives high impact strength than the other laminates considered. The Laminate-2 and Laminate-3 shows the better impact strength than laminate-1. The lower impact strength was found in Laminate-4.



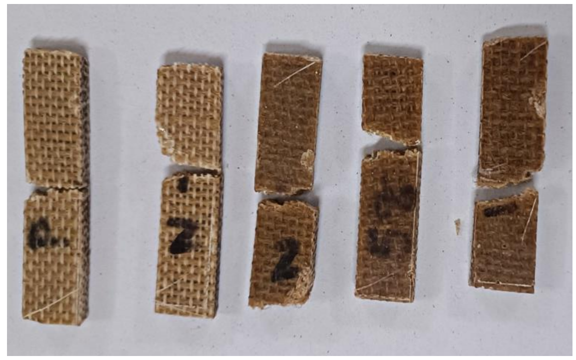


Fig-3.1 Laminate before impact testing **Fig-3.2** Laminate after impact testing

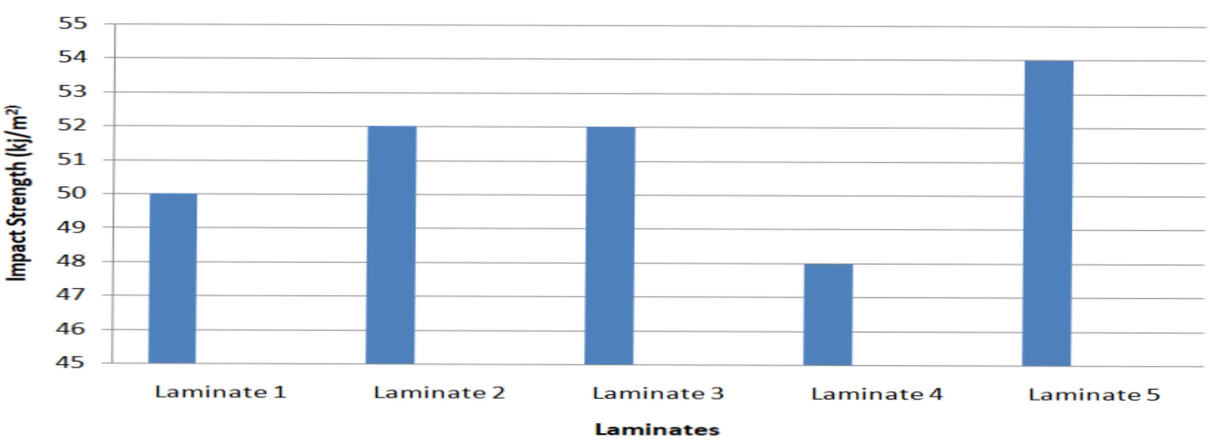


Fig 3.3 Impact strength Vs Different laminates

3.2 Hardness Test

The hardness of laminates L-1, L-2, L-3, L-4, and L-5 was determined using a hardness testing machine in accordance with the ASTM D785 standard. The test specimen's dimensions are (30 x 30 mm). On the Rockwell Hardness tester's surface, a reference sample is placed. The gauge is set to zero after a light load is applied. By pressing a lever, the main load is applied. The lift is done after 15 seconds. After giving the specimen 15 seconds to recover, the hardness is measured while still applying a light load. These observations are summarised in Table 3.2.

Table 3.2: Hardness Test Results

S. No	Laminates	Hardness Number[RHN]
1	L1	54.79
2	L2	54.63
3	L3	54.33
4	L4	54.99
5	L5	54.46

The broken area is located in the specimen's middle, as shown in Fig. 3.4 The hardness values of different laminates are shown in Fig-3.5.The results indicates that the laminate-4 gives better hardness number compared to other laminates and The Laminate-2 has the lowest hardness number.

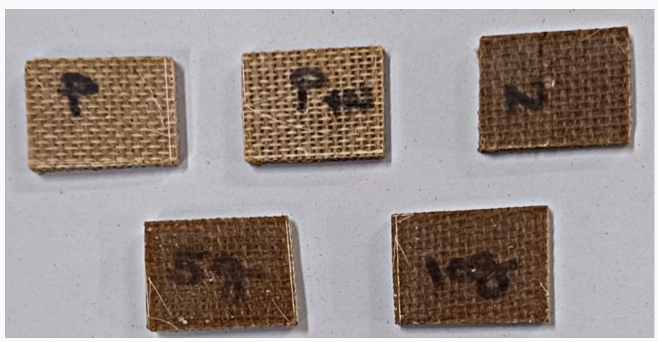


Fig-3.4 Laminates after hardness testing

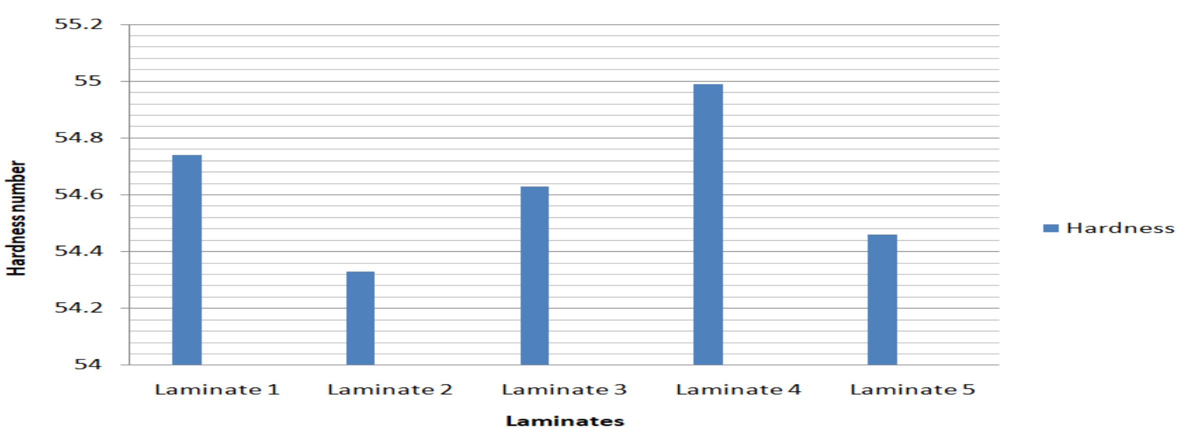


Fig -3.5 Hardness Number Vs Different laminates

4. Conclusions

In this investigation, polymer based laminates are fabricated with reinforced palm, jute fibers and sea shell powder by using the hand layup process. The following conclusions are inferred from impact and hardness test results.

- It is observed that the better impact strength was attained in laminate-5 when compared to laminate-2, 3 due to the addition of 10 grams of sea shell powder.
- It is noticed that to get better impact strength the minimum amount of seashell powder required in epoxy resin is above 10grams.
- The addition of sea shell powder to the resin resulted in higher hardness number in laminate-4 than laminate-3
- To attain high hardness value the amount of seashell powder should be or less than equal to 5g in the epoxy resin.
- Compared to pure palm fiber laminate 1, pure jute fiber laminate 2 has good mechanical characteristics.

From the above investigation laminate-5(composition (J-P-J-P) with 10g of sea shell powder) is recommended due to its better impact and hardness properties.

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