Evaluation Of Mechanical Properties Of Flax/Glass Fiber Reinforced Hybrid Polymer Composite

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Abstract:
The knowledge of mechanical properties of reinforced hybrid composites is very abundant, even though this could be one of the critical issues for many practical applications. This paper has the detailed study and a road to know more about the flax/glass fiber composites and its review on the appliance, property oriented with some of the special properties of the fiber. However, the occurrence of flax fiber is in the cooler regions of western country the worth of flax was more in the replacement of synthetic fibers as a replica of its own property in the application purposes Therefore, the current study was conducted to investigate the strength and performance of glass and flax fiber reinforced hybrid composite laminates by a comprehensive set of experiments. The method of preparation to prepare the laminates is by compression molding.

Keyboards: Flax/Glass fiber, Polyester Matrix, Hybrid composite, Compression Molding, Mechanical properties

1. Introduction

Fiber is one of the fibrous materials. It is available in plants and animals, vegetable tissue, mineral substance. Fibers are often used in manufacture of other materials. It contained more strength, some chemical contents are there. Flax is the most strongest among the natural cellulosic fibers. It is a basalt fiber. Flax fiber is extracted from the skin of the stem of the flax plant. A fiberglass is a form of fiber-reinforced plastic where glass fiber is the reinforced plastic. This is the reason perhaps why fiberglass is also known as glass reinforced plastic or glass fiber reinforced plastic. Polyester resins are the most widely used resin systems unsaturated polyester resin is a thermoset, capable of being cured from a liquid or solid state when subject to the right conditions. This study was aimed at comparing the thermal characteristics and low velocity drop weight impact properties of the glass and flax fiber epoxy composites at room and elevated temperatures (up to 300 °C). Regarding the fire properties, the inclusion of APP enhanced the flame retardancy of the composites [1]. An experimental study which includes the effect of fluid structure interaction was conducted to evaluate the dynamic response of three different laminate configurations under impulsive loading conditions [2].The present study investigated the effects of water absorption on the interlaminar fracture toughness behavior of woven flax and flax/basalt reinforced vinyl ester composite laminates [3]. Mechanical properties of the bio-composite can be calculated by estimating their relationship with the changes of *DP* over the temperature and time this relationship has separately been proposed for both matrix and fiber [4]. The objective of this study was to compare the effects of similar modifications in both fibers and matrix on the mechanical properties of flax fiber bundle/PP composites and also to compare them with those for a glass fiber/PP composite [5]. The mechanical characterization confirmed the higher properties for the laminates with carbon fibers over those with natural fibers only. The trend was reversed for the loss factor and thus in terms of damping [6]. Low melt sheath component present in HCP fiber itself act as a binding agent and adding of additional 5% low melt polyester fiber to improve the strength of the composites also act like external additives or binders [7]. Shear strengthening of reinforced concrete beam using externally bonded steel plate and carbon

fiber reinforced polymer laminate (CFRP) is the common practices in construction industry [8]. The Mode II experimental works were performed under 3ENF tests. Evaluation of mm,p the fracture energy initiation and propagation as well as the crack length under dry and wet conditions using CCM and SBT methods were carried out [9]. The simulation and experimental results of multilayer short fibers reinforced composites using five different design criteria are concluded, Natural fibres can be obtained in the nature, making them to be new materials for reinforced polymer composites for different engineering applications [10-11]. A review of the most extensive works performed on mechanical and rheological properties of thermoset composites reinforced by lignocellulosic fibres, has been elucidated while previously explaining the most extensively used manufacturing processes and characterizing tests for these composites in expanding phase [12]. The effect of water absorption on the mechanical properties of non-woven hemp fibre reinforced unsaturated polyester composites has been studied following immersion at room temperature and boiling temperature [13],it was found that using carbon fibre as top and bottom layers for composites would help reduce the size and defection of damage, as the flexural strength is controlled by the strength of the bottom layer as for structural design of bonnet, it was performed based on flexural strength[14-15]. The sisal/ GFRP, jute/GFRP, sisal/jute/GFRP composite samples are fabricated. The hybrids composite are subjected to mechanical testing such as tensile, flexural and impact test. Among various natural materials, natural fibers offer several advantages over synthetic materials in reinforcing composites, due to their bio renewable characteristic and eco-friendly behavior, and can be thus effectively utilized for various applications [16-17]. Biocomposites filled with natural fibers are nowadays very attractive. In order to extend their application fields, their fire behavior needs to be studied. However, the contact time was independent of impact energy and presented a constant value for each lay-up investigated [18-20].The detailed review of the literature sheds light on the variety of reinforces composites and how they are fabricated and what are the matrix materials used. It gives various opinions on the how composites have revolutisined the materials field of manufacturing. Fibers are extensively used in various fields and have variety of properties that makes it way for various applications hybrid composites are made from vast majority of fibers and reinforced materials.

2.Experimental Details

Compression molding is a closed-mold composite manufacturing process that uses matched metal molds with the application of external pressure. In the compression molding process, an engineered composite layup is placed in the open mold cavity, the mold is closed, and consolidating force is applied. The pressure remains on the mold throughout the cure cycle, which usually occurs in an oven. The combination of heat and pressure produces a composite part with low void content and high fiber volume fraction near net shape finished component. Compression molding often yields composite parts that have the optimal mechanical properties possible from the particular combination of constituent materials.



Fig 1. Compression Molding machine used to fabricate composite laminates

2.1 Fiber Preparation

Flax and glass fibers are mixed based on the relative weight percentage values for testing the mechanical properties of various proportions of composite laminates. The fibers are taken according to the relative weight percent of the other fiber used. The different proportions of the hybrid composite laminates gives the opportunity to test and provide a concrete result on the better and suitable proportion yielding required strength and properties. Instead of preheating, the

thoroughly mixed fibers are pre-compressed for a certain amount of time to make the fibers active for resin interaction. Pre-compression is applied for only proportions having more flax fiber content compared to glass fiber, as the flax fiber have a small amount of cushion or flocculent nature.



Fig. 2 Flax and glass fibers after thorough mixing

3. Results and Discussion

In this experimental analysis ten sample of various relative percentages of fibers are used to create composite laminates and three specimens for each testing and nine specimens from each laminate is taken to carry out the testing procedure. The following table 1 and figure 3 gives the detailed view on the fiber content of each sample and the relative weight percentages are also mentioned.

Table 7.1: Sample Relative Weight Percentage

Sample	Flax (gm)	Glass (gm)	Wt.% of Flax	Wt.% of Glass
1	80	0	100	0
2	72	8	90	10
3	64	16	80	20
4	56	24	70	30
5	48	32	60	40
6	40	40	50	50
7	24	56	30	70
8	16	64	40	80
9	8	72	10	90
10	0	80	0	100

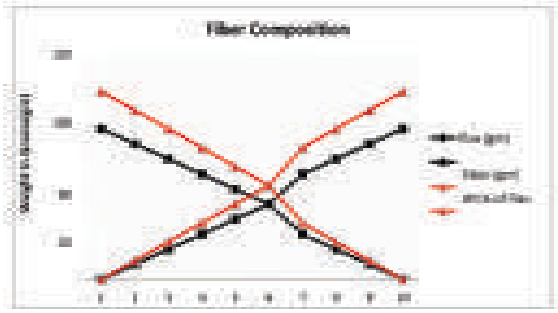


Fig 3. Flax and Glass Content in sample

3.1Tensile, Flexural and Impact Test Result

Each specimen yielding results from tensile, flexural and impact testing will taken into consideration and the final plotting is dine with the help of average values of the test results. The following table.2 shows the test results obtained from each test in N/mm^2, from the results , it is convenient to derive our final conclusion on which sample has highest strength based on average value. The tensile, flexural and impact testing are carried out under ASTM standards ASTM D 638, ASTM D 790 and ASTM D 256 respectively. The test results are plotted on graph having x-axis as sample number and the y-axis parameter is taken as strength obtained in each result in N/mm^2. Three specimens for each testing gives nine results for each sample. The average of the three results is calculated and is considered for the discussion into final conclusion.

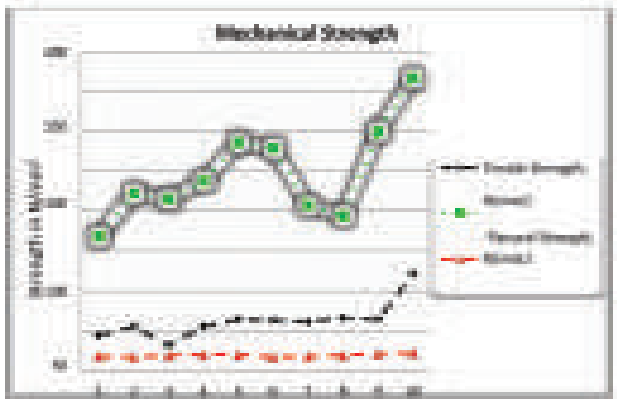


Fig 4. Mechanical Strength

Conclusion

This study focuses on utilizing inexpensive flax and glass fibers as reinforcement towards

Table 2: Test Results
(Tensile, Flexural and Impact Test)

Sample ID	Tensile Strength, N/mm² ASTM D 638			Flexural Strength, N/mm² ASTM D 790			Impact Strength, N/mm² ASTM D 256		
	1	2	3	1	2	3	1	2	3
1	47	44	41	157	182	164	18	17	19
2	68	62	34	224	224	217	16	18	17
3	39	31	25	194	194	256	18	19	18
4	54	61	50	223	223	268	20	21	18
5	77	61	54	286	286	285	18	22	19
6	60	55	75	269	269	299	17	16	18
7	54	54	76	189	189	243	17	18	20
8	51	54	94	196	191	194	19	18	19
9	94	48	51	321	287	293	22	21	19
10	115	180	68	386	312	402	23	21	23

producing polyester flax/glass laminates, thus bringing economic value to flax fibers. The results show us that the pure glass fiber laminate shows maximum strength on all tensile, flexural and impact parameter. From the following graph, we can assume that the samples 5,6,9 and 10 show maximum strength from which we can conclude that the samples having relatively equal proportions of flax and glass fibers and having high glass content exhibit high tensile, flexural and impact properties.

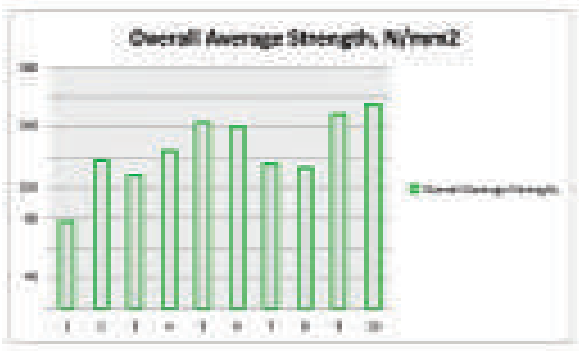


Fig 5. Overall strength values

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