Experimental Investigation of Mechanical Properties of Basalt Fiber Reinforced Hybrid Composites

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Abstract – Glass fibers are the most common of all reinforcing fibres for polymer matrix composites. In this experiment work Basalt fiber was used as a polymer reinforcing material in thermoset matrix composites. The present work is focused on different basalt preforms combination with Polypropylene and Glass to produce hybrid structure. The objective of this work is to investigate the applicability of basalt fiber combined with different types of fibers and structures. The mechanical properties of Basalt Fiber reinforced composite has been analyzed. The mechanical properties were improved as the fibers reinforcement content increased in the matrix material.

Index Terms – Basalt Fibre, Fibre Reinforced Plastic, Hybrid Structure, Mechanical properties.

1. INTRODUCTION

Composite materials are produced by combining two dissimilar materials into a new material that may be better suited for a particular application than either of the original material alone. Many of our modern technologies require materials with unusual combination of properties that cannot be met by the conventional materials [11]. This is very true for materials that are needed for the aerospace, underwater and automotive application. Many composite materials are composed of just two phases one is termed the matrix, which is continuously surrounded by the other phase, often called the dispersed phase

Basalt fibre is a natural material which is produced from igneous rock called basalt. Basalt is quarried, crushed and washed and then melted at 1500° C. The molten basalt is drawn into filaments. When the filaments cool down it is transformed into fibres[1].The basalt fibres do not contain any other additives in a single producing process, which gives additional advantage in cost. It is reported by researcher that basalt fibres have better tensile strength than E-glass fibres, greater failure strain than carbon fibres as well as good resistance to chemical attack, impact load and fire with less poisonous fumes[2].Basalt materials are attractive for creation of composites with polymeric and inorganic matrices. The main advantages are low price of raw materials, cheap production of filaments and possibilities of creation of textile structures [3]. Basalt continuous fibres offer prospect of a completely new range of composite materials and products. Basalt have no toxic reaction, non-combustible and explosion proof. When in contact with other chemicals they produce no chemical reactions that may damage health or the environment [4].

2. OBJECTIVES OF THE WORK

Several articles dealing with glass and carbon fiber reinforced polymer composites mention the significance of basalt fiber as a possible new reinforcing material [7]. There are only a few researchers who managed to create a composite to embed basalt fibers in a polymer matrix [8, 9]. The main reason is the problem of fiber-matrix interfacial interaction and the high sensitivity to fracture in basalt fibers. In recent years, more and more attentions have been paid to basalt fibers as well as its FRPs on its mechanical properties, durability in various environments [10]. The Basalt fibres can easy damage and having poor bending property and un-consolidated layers especially over the exterior surface, mainly because of the less fibre-matrix interaction. The hybridization of preforms can be one of the solution by mixing two different fiber materials at yarn or preform stage in the same matrix system to improve the properties for thermoset as well as thermoplastic laminates. In particular, the attention of the present work is focused on different basalt preforms combination with Polypropylene and Glass to produce hybrid structures. The main objective of study the physical and mechanical property of different basalt preforms combination structures and consolidates in to laminates.

3. MATERIAL AND METHODOLOGY

The Polypropylene Tap fabric (PPF), Basalt fabrics (BF) and Polypropylene Tape yarn in warp and Basalt in weft (PPF/BF) plain weave woven preforms taken for study. The PPF and PPF/BF fabric was manufactured on projectile weaving machine at Shanker Packaging. This fabric Tested using ASTM standard method. The properties of preforms are given in Table 1. These preforms use for preparing composite sheet of 16 layer of different combination and alignment.

Type of Preform	EPI * PPI	GSM	Thickness in mm
BF	13 * 13	300	0.25
PPF /BF	15 * 11	180	0.30

Table 1 Properties of Preform

The epoxy resin was used as matrix material. The laminates were prepared using vacuum infusion resin for manufacturing the BFRP in thermoset laminate. First apply the release agent on the table surface. 3 layers of release agents have to apply each after 30 sec. Then place the fabric samples as per sample plan as shown in Table 2.

Sample code	Stacking Sequence	Fiber Orientation
B1	B16	0 B
B2	B4 PB8 B4	0 B 0 PB 0B
B3	PB6 B4 PB6	0PB 0B 90PB

Table 2 Sequence of fabric layers in laminate

The laminates were prepared using vacuum infusion resin for manufacturing the BFR After that pill ply fabric has been spread over it. Then perforated foil also kept over it. Finally green colour mesh was spread over it so it will provide the channels to pass the resin throughout the sample evenly. After the required amount of resin was passed now keep the sample at room temperature for 24 hrs. These laminates were tested using slandered method for Tensile test IS0 527-4, Flexural ASTM D790-10, Short beam strength (Shear) ASTM D 2344-13.

4. RESULTS AND DISCUSSIONS

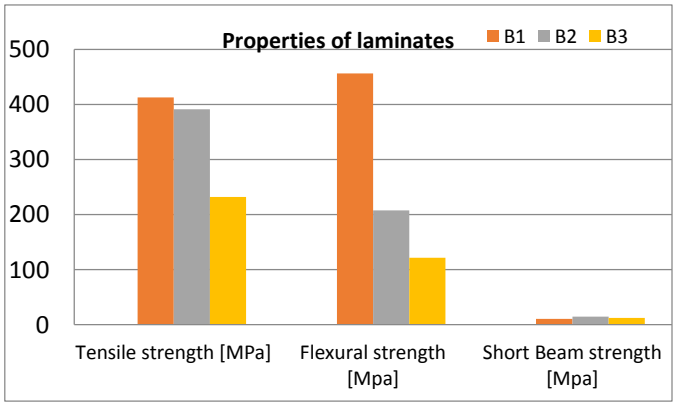

Figure 1 Properties of laminate

The 16 layer laminate prepared with different combination. The B1 have all Basalt preform layer give higher value of tensile and flexural Strength due to 100% of basalt fibre content. The B2 and B3 have PPF/BF combination preform layer with Basalt preform. The Table 3 shows the mechanical properties of laminates. The main objectives of abounded polypropylene along with the basalt are to improve adhesion between layers and interlaminer properties of composite sheet.

The result shows that basalt composites have higher strength and stiffer compare to B2 and B3. B2 shows little lower strength but improve bending due to polypropylene content. The PPF content need to optimize to improve adhesion of BF layers such a way that it cannot much affect the mechanical strength. B3 give poor mechanical properties compare to B2 due to higher PPF content. The Short Beam Shear test subjects a beam to bending, just as flexural testing methods do, but the beam is very short relative to its thickness. The objective is to minimize the flexural (tensile and compressive) stresses and to maximize the induced shear stress. So that gives measure of shear strength of sample which improves with addition of PPF in thermoset composite.

5. CONCLUSION

In present study, it was found that, the content of basalt filler affected structural integrity and mechanical properties of composites. Hence as the content of Basalt filler increase in the laminate it will increase the mechanical properties of laminate. The hybridization of preforms or introducing PPF

layer between preforms improves adhesion between BF layers. Composite laminates are assemblies of hybrid material layers, which can be joined to provide required engineering properties, including in-plane stiffness, bending stiffness, strength, and coefficient of thermal expansion.

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