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Study of Glass & Jute Fiber Reinforced Polyester Hybrid Composite without and With Aging Environment under Impact Loading

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Abstract: Polyester is all ways known for its affordability, but at the same time careful handling is required. The investigation is carried out on the Polyester composites reinforced with glass and jute fiber with three different fiber orientation - 0˚, 30˚and 45˚ which was fabricated by hand lay-up technique to form hybrid composites. It is essential to assess the mechanical properties of these composites which were exposed to varying aging environment (sea water) before it is subjected to the real practical application. The impact test results obtained shows that the composite at 30˚ fiber orientation has improved the impact strength of composites when compared, even under varying aging conditions.
Keywords: Aging, Glass fiber, Hybrid, Impact strength.

I. INTRODUCTION

Composite materials are often used in environments in which they will suffer from impact damage. For example, damage can occur from a hammer being dropped on a composite pipe or from a bullet striking composite armor. Since impact damage resistance is such an important property for composite materials, this chapter will be devoted to the theory behind impact testing, and the procedures used to perform impact testing [1]. In terms of structure, materials can be divided into four basic categories: metals, polymers, ceramics, and composite materials. A composite structure is a material composed of two or more phases combined in a macroscopic scale, whose properties are superior constituent materials, acting in an independent manner. In other words, a composite combining at least two different materials both chemically and geometrically [4, 6]. Unlike metals, fiber reinforced composite materials don't undergo plastic deformations after the impact. Near the impact area may appear elastic deformations (in the case of a low intensity impact) or deteriorations of the material (the separation of the fibers from the matrix, matrix cracking, and fiber breaking) [6].

The absorbed energy consequent to the impact depends, among others parameters, on the fiber – resins link resistance. If this link is strong, a continuous crack may spread along the material. In the case of a weak link, the generated crack may have an irregular form, leading to a rapid separation of the fibers from de matrix and to considerable absorption energy. When designing the composite materials, it is necessary to make sure that the links between the fibers and the matrix aren't too weak, because a low shear resistance also influences in a negative way the impact behavior [3].

A simple analysis method of impact properties is the measurement of the stiffness expressed in the necessary energy for breaking a random geometry bar. For homogeneous and isotropic materials, Izod or Charpy conventional tests and notched bars are being used – which lead to great tension concentrations, thus minimizing the energy necessary for breaking [2].

These tests may be also successfully used in the case of the composite materials, for comparative studies. Although the deterioration mechanisms (matrix crack, fiber separation or yield) may occur in an independent manner, the interaction of these factors and the fiber type, the matrix type/state and environment state and matrix – fiber links define the impact and the possible yielding of the material as a very complex phenomenon [4].The types of composite material (short/random/continuous fiber with thermoset/thermoplastic matrices) and their applications (aerospace /automotive /civil/marine) vary widely, so that no single test can readily quantify the myriad of potential impact situations and their subsequent effect.

This may in itself require further post-impact testing to measure the desired residual property (e.g. strength, stiffness, etc) [6]. Polymer composites have become popular due to their ability to modify the mechanical and tribological properties by incorporating the reinforcement fibers and particulate fillers. The use of composite materials off shores has increased over the last years. Data in

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sea water environment are more difficult to find [7].

II. EXPERIMENTAL DETAILS

A. Experimental Materials and Manufacturing Method

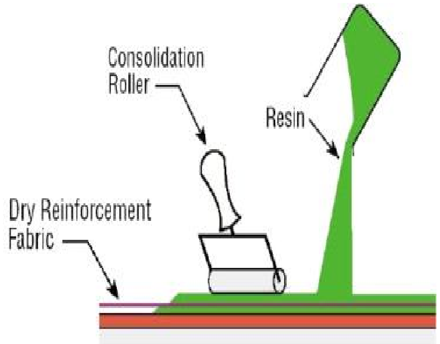

Figure1: Hand Lay-up Method.

Glass fiber woven mate (E-glass and Density 200 g/cm^3) and jute fiber was used as a reinforcing materials in unsaturated polyester to form hybrid composites. The matrix material of unsaturated polyester resin plus Methyl ethyl ketone peroxide (MEKP) as accelerator. As regards to the processing, on large granite stone a release film was placed first and it was coated with anti adhesive gent. On it Glass fiber woven mat and jute fiber are placed at different fiber orientation, on which a mixture of matrix system (consists of matrix material of unsaturated polyester resin plus Methyl ethyl ketone peroxide (MEKP) as accelerator, plus cobalt as a catalyst and is coated with help of a hand brush. Dry hand lay up technique was employed to fabricate the composites as shown in the figure 1. The stacking procedure was followed: placing of the glass fiber woven mat one above and inside the jute fiber with the mixture prepared well on it and covering film was again used to complete the stack.

To ensure approximate thickness of the sample, spacer was used. At the last again release film coated with anti adhesive agent was kept and on it another large granite stone was again placed over it to apply enough load on it was also coated with anti adhesive agent in order to aid the ease of separation on curing. Enough loads were ensured and then it was allowed to cure for a day at room temperature. Test samples according to ASTM D-256 (ASTM STANDARDS) were prepared from the cured sheet using cut-off machine. Then certain sets of samples were kept in container containing sea water for ageing to occur and certain were not.

1) Impact Testing

Figure 2: Picture of Digital Impact Testing Machine

Digital Impact testing machine which is used which is shown in figure 2. A sophisticated data gathering algorithm might be expected to adjust the rate of data collection in conjunction with varying rates of change in load or strain, and so on. Most testing machine is intended to be used in routine testing and permits the information such as impact energy, and other statistical analysis of

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the results. It is common to refer to the impact resistance of a material. However, this is an all-embracing term that can refer to many quite different aspects of a materials behavior in a given structure.

The impact 'resistance' of a composite may refer to the ability of the composite to withstand a given blow without any damage (i.e. the resilience); the maximum force necessary to rupture or separate a composite structure, irrespective of the preceding level of damage (the impact strength); the amount of energy that is absorbed by a given mass of the composite (the crush resistance); or perhaps the level of damage that a composite can sustain during impact loading without suffering undue reduction to some primary structural function after the impact event(damage tolerance).

Impact loading is usually taken to mean the impact of either a projectile or the composite itself at speeds in the range 1–10ms-1. This phenomenon has received the greatest attention to date, as out-of-plane impacts in this velocity range may have catastrophic consequences on the subsequent load carrying capability of the structure. Impact testing machine is calibrated before the test then place of the specimen in the top position and lock it. Specimen is fixed on the slot in the form of a vertical cantilever such that V-notch is facing striking edge of the pendulum and longer part of the specimen is held in the slot.

Now the impact load is applied, by releasing the pendulum. As the pendulum hits the specimen placed in the slot, the load absorbed is digital displayed and noted down.

III. RESULTS AND DISCUSSION

Sl No.	Charpy Impact Strength in KJ/mts^2		
	Without Aging	With Aging for I Month	With Aging for II Months
1	22.76	21.27	12.51

Table 1: 0˚ Fiber Orientation of Hybrid Composite

Sl No.	Charpy Impact Strength in KJ/mts^2		
	Without Aging	With Aging for I Month	With Aging for II Months
1	52.87	43.39	21.74

Table 2: 30˚ Fiber Orientation of Hybrid Composite

Sl No.	Charpy Impact Strength in KJ/mts^2		
	Without Aging	With Aging for I Month	With Aging for II Months
1	47.5	21.06	15.47

Table 3: 45˚ Fiber Orientation of Hybrid Composite

The values shown in the table from 1 to 3, when compared gives the better result for the 30˚ fiber orientation of a glass fiber and jute polyester hybrid composite, then the remaining samples with or without aging. It is clear from these results obtained that for all the glass fiber and jute fiber polyester hybrid composite used in this study there are better impact energy is seen at 30˚ fiber orientation. It indicates better impact strength. The lowest values 45˚ and 0˚ fiber orientation of hybrid composite even under aging.

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IV. CONCLUSION

From the fig. 3, the impact behavior of the samples of glass fiber and jute fiber reinforced polyester hybrid composites under sudden loading were compared and studied for varying fiber orientation with or without aging conditions in this composite material, the following conclusions are drawn:

A. Impact test results with 30˚ fiber orientation of the material has better impact strength when compared to 45˚ and 0˚ fiber orientation of hybrid composite without and with varying aging conditions.

B. The hybrid composite was successfully developed by hand layup technique at different fiber orientations.

C. For 30˚ fiber orientation of the material, the Charpy impact Strength was 52.87 KJ/mts^2.

D. It can be seen that there is decrease in impact strength when compared with 45˚ and 0˚ fiber orientation of hybrid composite.

E. Finally the glass and jute fiber- reinforced polyester hybrid composite with 30˚ fiber orientation is said to be optimal, with and without aging conditions reason behind this is due to good fiber inter-locking between the fibers and proper adhesion.

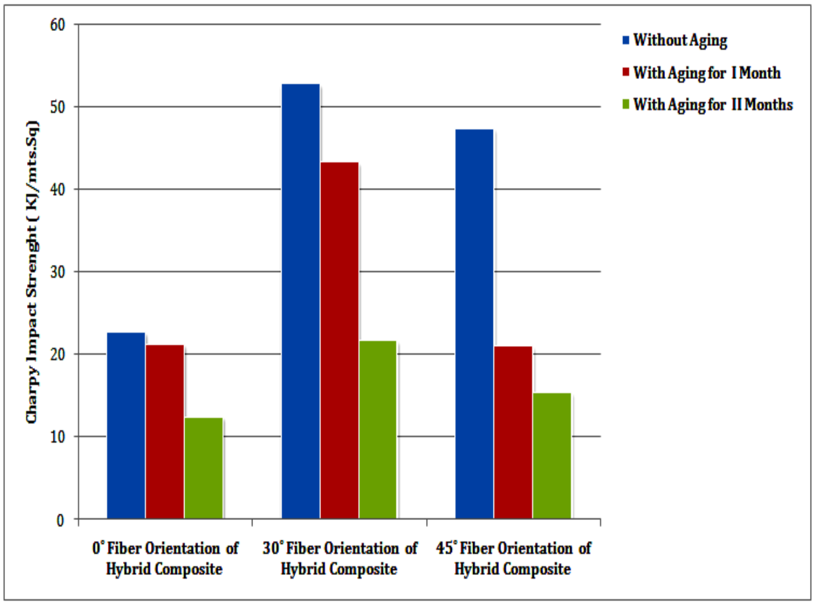

Fig: 4 Comparison of Impact Strength (KJ/m^2) of Hybrid composites.

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