STUDY OF EFFECT OF WATER TREATMENT ON FLEXURAL PROPERTIES OF GFRP COMPOSITES

Mr.J.RAJASEKHAR[1], Mr. D.HARSHA VARDHAN[2]

[1] *P.G. Scholor, Sri Venkateswara Institute Of Technology, Anantapuram,AP*
[2]*HOD, Department of Mechanical Engineering, Sri Venkateswara Institute of Technology, Anantapuram.,AP*

Abstract: *Now-a-days composite materials applications are extensively growing because of their versatile properties. Attempts have been made in this research work to study the effect of water treatment on the mechanical behavior of glass fibre reinforced epoxy based composites. Composites were fabricated using simple hand lay-up technique. Water treatment was conducted by immersing specimens in a normal bore well water bath at 25 ^{0}C for different time durations. Then flexural properties of water immersed specimens subjected to both aging conditions were evaluated and compared alongside dry composite specimens. It has been observed that there is a significant effect of water immersion on the flexural strength of glass fibre reinforced epoxy based composites.*

Key Words: *Water Treatment, Glass fibre, Flexural strength, GFRP*

1. INTRODUCTION

Composite material is made of two or more different constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from individual materials. These are not new to the mankind; it has a history of more than 3000 years. In ancient Egypt, people used to build walls from the bricks made of mud with straw as reinforcing component [1]. Hybrid composites are commonly termed as the mixture of two or more reinforcing fibres in a single matrix system. Through proper fibre selection and design, the balance between cost and performance of hybrid composites could be achieved through hybridization [2].

Because of their various benefits they're widely utilized in the part business, industrial applied science applications, like machine parts, vehicles, combustion engines, mechanical parts like drive shafts, tanks, brakes, pressure vessels and flywheels, thermal management and electronic packaging, railway coaches and craft structures etc.

Three types of fiber-reinforced polymeric composites were investigated by Selzer and Friedrich [3] to find out moisture effects on the mechanical properties and the failure behavior. Two thermosetting matrices (unmodified and toughness-modified epoxy) and one thermoplastic matrix (polyetheretherketone) were used. These properties were decreased by moisture absorption, which was ascribed by the authors to the weakening of bonding between fiber and matrix and softening the matrix materials. N Pavan Kuamr et al [4] and K.Kalyan Krishna et al [5] fabricated GFRP Composites by hand layup and observed that the flexural strength of the composite greatly influenced by the percentage of filler. Kawaguchi et al. [6] studied hot water immersion testing and tensile testing on three kinds of short glass fiber or glass bead-reinforced plastics (PPE, PPS, POM). A degradation of the strength was observed for reinforced plastics under hot water immersion and the change of the tensile strength was found to be most drastic in glass fiber-reinforced PPS (GFPPS). Scanning electron microscope (SEM) observations of the tensile fracture surface and the results of acoustic emission analysis revealed that the change in tensile strength was attributable to the deterioration of the interface between the glass fiber and the matrix resin Mechanical loading and moisture conditioning effects on Eglass/ epoxy composite were examined by Abdel-Magid [7]. After short duration (500 and 1000 h) of applied tensile stress and submergence in distilled water at room temperature, the material exhibited an increase in strength, decrease in modulus, and increase in strain to failure. After longer duration (3000 h) of applied stress and moisture conditioning at room temperature, a significant decrease in strength and strain-to-failure was exhibited indicating crack propagation in the matrix and at the interface causing the material to be less ductile and more brittle. When the conditioning temperature was raised to 65 C for 1000 h, the strength decreased by 18%, and the modulus decreased by 28% while the strain-to-failure increased by 18%. It was concluded that the applied stress has a positive effect on the material in short-term, and that the effect of load and water at room temperature is quite different from their effect at high temperature.

Water immersing tests on composites reinforced by low cost natural plant fibers, Following immersion at room temperature and boiling temperature, the effect of water absorption on the mechanical properties of non-woven hemp fiber reinforced unsaturated polyester composites has been studied by Dhakal et al. [8]. The study showed that, moisture uptake increase with fiber volume fraction increases due to increased voids and cellulose content. The water absorption pattern of these composites at room temperature is found to follow Fickian behavior, whereas at elevated temperature the absorption behavior is non-Fickian. Water uptake behavior is radically altered at elevated temperatures due to significant moisture induced degradation. Exposure to moisture results in significant drops in tensile and flexural properties due to the degradation of the fiber–matrix interface.

2. MATERIALS AND METHODS

Current work is on composite made up of woven glass fibre reinforcement and epoxy as matrix material. The epoxy resin LY556 and the corresponding hardener HY-951 is used as matrix material.

2.1. Composite fabrication

The fabrications of the composite slab were carried out by conventional hand layup technique. The low-temperature curing epoxy resin and corresponding hardener were mixed in a ratio of 10:1 by weight is taken. Composites were fabricated and subjected to post-curing at room temperature for 24 h. Then sample specimens are cut for required dimensions. Total 2 samples were considered for study two samples without treatment and two specimens for 5 days and 10 days treatment.

2.2. Water Absorption or water treatment

Moisture absorption studies were performed according to ASTM D 570-98 [9] standard test method for moisture absorption of plastics. The samples were taken out periodically and after wiping out the water from the surface of the sample weighted immediately using a precise balance machine to find out the content of water absorbed. The specimens were weighed regularly at 24, 48, 72, 96, 120, 144, 168, 192, 216, 240 hours. The moisture absorption was calculated by the weight difference. The weight gain in percentage of the samples was measured at regular time intervals of time.

2.3 Flexural strength

The flexural strength of a composite is determined by the maximum bending stress that it can withstand during bending before getting the breaking point. The flexural strength measured in three-point bend test to understand the flexural behavior of composites using the universal testing machine on ASTM D790 [10] specimen using UTM. Samples are tested at a cross head speed of 10 mm/min, in an UTM machine.

- Dimensions of ASTM D790 Flexural specimen are 127×13×3 mm^3

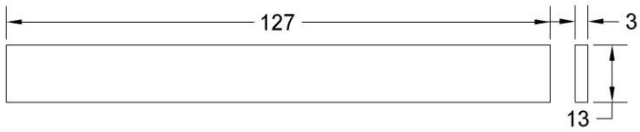

Figure 2: Dimensions of flexural test specimen

Flexural strength = $3PL/2bd^2$

Where, “P” represent maximum load.
“b” width of specimen.
“t” thickness of specimen
“L” span length of the specimen.

3. RESULT AND DISCUSSIONS

3.1 Water absorption

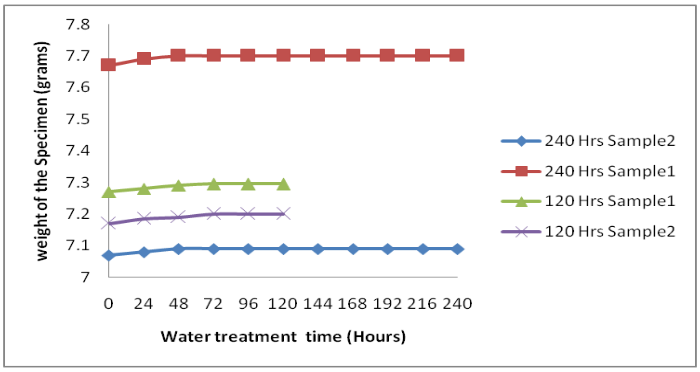

Figure 3: Effect of water treatment time on water absorption and weight gain

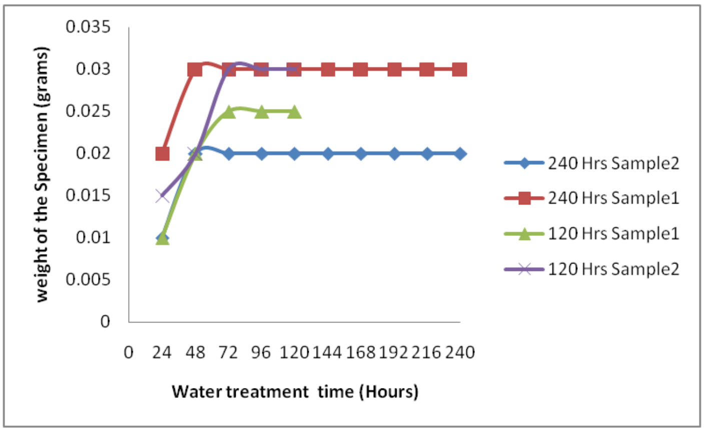

Figure 4: Effect of water treatment time on weight gain of specimen

After 240 hours of observation, it is clear that the Epoxy based GFRP composites has less water absorption capacity and figure-3 shows that the weight of the specimen increased upto 72 hours of water treatment then it is stable. Figure four shows that the weight gain of the GFRP Composite added very little amount of weight that is maximum 0.03 grams.

3.2 Flexural strength

Flexural strength results are tabulated as below

Table 1 : Flexural test results

Sample	Flexural Strength (N/mm^2)
Untreated sample 1	4310
Untreated sample 2	4353
sample 1 5 days	4115
sample2 5 days	4164
sample 1 10 days	4310
sample2 10 days	4278

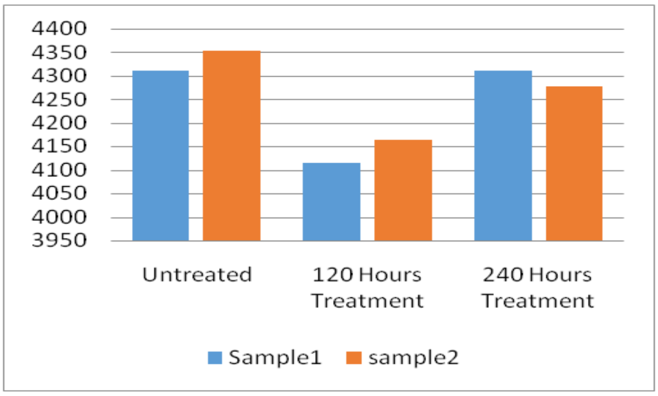

Figure 5: Water Treatment effect on Flexural Strength of GFRP

From the results it is observed that the water treatment has significant effect on the flexural strength, as the flexural strength is decreased after the 5 days treatment, it has been observed that the even though there is no notable weight gain in samples between 120 to 240 hours of treatment, but flexural strength is increased for 240 hrs treated specimens.

4. CONCLUSIONS

The experimental study on the effect of water treatment on flexural strength for glass fibre reinforced epoxy based composites leads to the following conclusions:

1. Glass fibre composite material absorbed very less amount of water i.e maximum 0.03 grams
2. Glass fibre composite has maximum flexural strength for zero and 240 hours of water treated ones.
3. Even though there is no notable weight gain in samples between 120 to 240 hours of treatment, but flexural strength is increased for 240 hrs treated specimens
4. There is a significant effect of water immersion on the flexural strength of glass fibre reinforced epoxy based composites.

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BIOGRAPHIES

P.G. Scholor, Sri Venkateswara Institute Of Technology, Anantapuram, Andhra Pradesh.

HOD, Department Of Mechanical Engineering, Sri Venkateswara Institute Of Technology, Anantapuram, Andhra Pradesh.