

Investigation on Mechanical Properties of Glass and Carbon Fiber Reinforced With Polyester Resin Composite

*R B Durairaj, G Mageshwaran, V Sriram

Faculty of Mechanical Engineering, Sathyabama University, Chennai 600119, India

Abstract : In this paper it is discussed about the mechanical properties of glass fiber reinforced with polyester resin composite and carbon fiber reinforced with polyester composite were observed. These composites are prepared in the proportion of GF 10%, GF 15%, and GF 20% for Glass fiber reinforcement with polyester resin and CF5% and CF10% for carbon fiber reinforcement with polyester resin to form composites. To identify the mechanical properties of the composites we have undergone various tests like tensile test, Flexural test and Impact strength for the samples. It is observed that the mechanical properties for GF15% , GF20% and CF10% shows higher values when compared to CF5% and GF10% and Polyester resin samples due to the higher proportion of fibers in the polyester resin. The tensile and flexural samples were prepared as per ASTM standard and corresponding values are tabulated and graphed.

Keywords: Glass fiber; Carbon fiber; Polyester resin; tensile test; Flexural test Reinforcement.

Introduction

Natural fibers in composite reinforcement exhibit excellent properties like light weight, and high specific properties [1-2]. Polyester resin reinforcement with coconut fibers exhibits higher tensile strength and light weight and highly flexible, can easily deform to high strain values [3-5]. The unsaturated sisal-glass composite were undergone various mechanical testing. It is observed that the tensile properties are higher compare to the sisal-glass fiber matrix[6,13-35]. Fiber reinforced composites produce medium impact to temperatures. As the temperature increases and the impact strength of the composites will decrease gradually [7-8]. The natural fiber bagasse has been reinforced with polyester resin and its mechanical properties were noted. It is observed that tensile and flexural characteristics and the fiber composite are increasing with increase in proportion of bagasse fiber in polyester.

Materials and Methods

The Glass fiber and Carbon fiber are reinforced with polyester resin to form a composite structure. The glass fiber reinforcement has been done in the proportions of GF 10%, GF 15% and GF 20% with Polyester resin. Similarly the Carbon fiber in the proportions of CF 5% and CF 10% with polyester resin. The weight of the composites was measured as GF 10% with 6.88g, GF 15% with 103g, GF 20% with 137g, CF 5% with 21.6g and CF 10% with 43.2g respectively. This composites were undergone various testing like tensile, flexural and impact strength. The composite samples are shown in fig 1.

Experimental work

The tensile strength, flexural strength and impact strength has been calculated and tabulated for the samples. In tensile testing the breaking load of the samples were calculated and listed in table 1.

Correspondingly the impact load of the composite samples are observed to calculate the impact strength and tabulated in table 2



Fig 1 Composite samples for Testing

Table 1 Breaking load for the tensile test

| | Glass Fiber 10% | Glass Fiber 15% | Glass Fiber 20% | Carbon fiber 5% | Carbon fiber 10% | Polyester resin 100% |
|-----------------------------------|------------------------|------------------------|------------------------|------------------------|-------------------------|-----------------------------|
| BreakingLoad Sample 1 (KN) | 0.480 | 0.330 | 0.425 | 0.470 | 0.540 | 0.460 |
| BreakingLoad Sample2 (KN) | 0.400 | 0.300 | 0.380 | 0.500 | 0.550 | 0.420 |
| BreakingLoad Sample3 (KN) | 0.490 | 0.370 | 0.480 | 0.450 | 0.430 | 0.490 |

Table 2 Impact Load observed for samples

| | Glass Fiber 10% | Glass Fiber 15% | Glass Fiber 20% | Carbon fiber 5% | Carbon fiber 10% | Polyester resin 100% |
|---------------------------------|------------------------|------------------------|------------------------|------------------------|-------------------------|-----------------------------|
| Impact Load Sample 1 (J) | 0.4 | 0.9 | 0.3 | 0.7 | 0.7 | 0.8 |
| Impact Load Sample 2 (J) | 0.3 | 0.7 | 0.4 | 0.8 | 0.7 | 0.5 |
| Impact Load Sample 3 (J) | 0.4 | 0.8 | 0.4 | 0.8 | 0.8 | 0.9 |

Result and Discussions

The Tensile strength of the samples was calculated and a graph has been plotted with tensile strength of the sample with proportion of fibers with polyester resin. Also a graph has been plotted with tensile load with the sample shown in fig 2. The tensile strength of the samples was tabulated in table 3 and corresponding graph has been plotted in fig 3. It is observed that CF 10% with polyester resin sample shows greater breaking load in tensile test. Similarly GF 20% has greater tensile strength of 0.021 KN/mm² when compared to other samples.

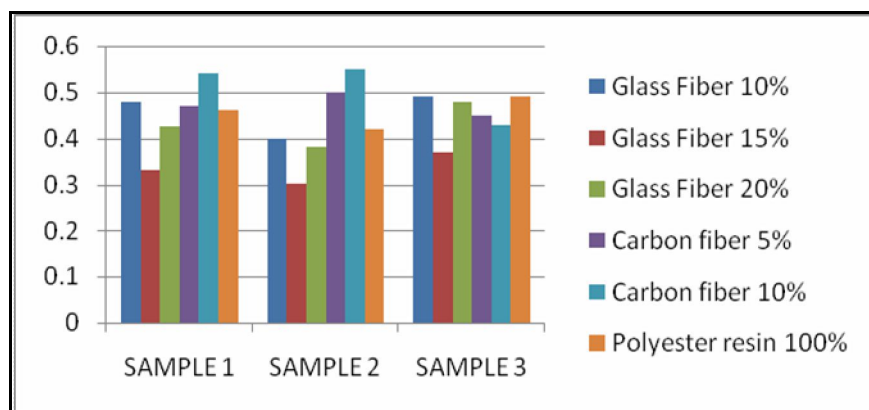


Fig 2 Breaking load graph of samples

Table 3 Tensile strength of various samples

| | Glass Fiber 10% | Glass Fiber 15% | Glass Fiber 20% | Carbon fiber 5% | Carbon fiber 10% | Polyester resin 100% |
|----------------------------------|-----------------|-----------------|-----------------|-----------------|------------------|----------------------|
| Tensile strength Sample1(KN/mm2) | 0.020 | 0.014 | 0.021 | 0.016 | 0.019 | 0.014 |
| Tensile strength Sample2(KN/mm2) | 0.017 | 0.013 | 0.018 | 0.017 | 0.019 | 0.013 |
| Tensile strength Sample3(KN/mm2) | 0.021 | 0.016 | 0.023 | 0.015 | 0.015 | 0.015 |
| Average | 0.019 | 0.016 | 0.021 | 0.016 | 0.018 | 0.014 |

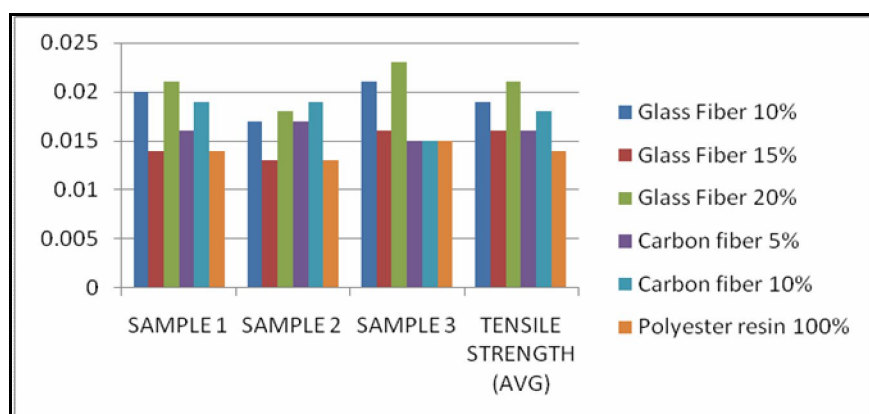
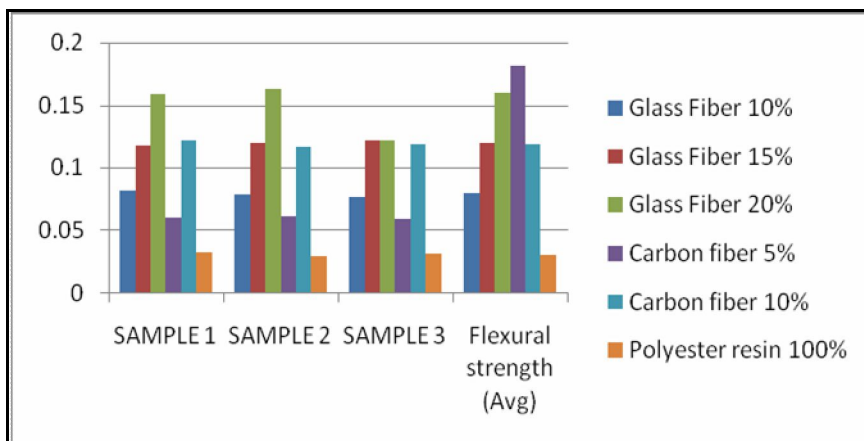


Fig 3 Tensile strength graph of various samples

Table 4 Flexural strength of the samples

| | Glass Fiber 10% | Glass Fiber 15% | Glass Fiber 20% | Carbon fiber 5% | Carbon fiber 10% | Polyester resin 100% |
|--|-----------------|-----------------|-----------------|-----------------|------------------|----------------------|
| Flexural strength Sample1(KN/mm ²) | 0.081 | 0.118 | 0.159 | 0.060 | 0.122 | 0.032 |
| Flexural strength Sample2(KN/mm ²) | 0.078 | 0.120 | 0.163 | 0.061 | 0.117 | 0.029 |
| Flexural strength Sample3(KN/mm ²) | 0.076 | 0.122 | 0.122 | 0.059 | 0.119 | 0.031 |
| Average | 0.079 | 0.120 | 0.160 | 0.181 | 0.119 | 0.030 |

The flexural strength of the samples were calculated and tabulated in the table 4 and corresponding graph for the flexural strength and various proportion of the samples were plotted in fig 4. It is observed that CF 5% and GF 20% shows maximum flexural strength in the graph plotted when compared to other samples. The CF 5% has a flexural strength in average of 0.181 KN/mm² and GF 20% in average of 0.160 KN/mm². The polyester resin samples (PR 100%) shows lower flexural strength of 0.030 KN/mm².

**Fig 4 Flexural strength graph of the samples**

Finally the impact strength of the samples was tabulated in table 5 and corresponding graph has been plotted with impact strength with various proportions of the composite samples. The graph for the impact strength is shown in fig 5. It is observed that GF 15% samples have greater impact strength of 0.021 J/mm² when compared to other samples. And GF 20% has very lower impact strength of 0.009 J/mm². It is optimized that 5 % increase of glass fiber will reduced the impact strength of the samples.

Table 5 Impact strength of the samples

| | Glass Fiber 10% | Glass Fiber 15% | Glass Fiber 20% | Carbon fiber 5% | Carbon fiber 10% | Polyester resin 100% |
|--|-----------------|-----------------|-----------------|-----------------|------------------|----------------------|
| Impact Strength Sample1 (J/mm ²) | 0.010 | 0.024 | 0.008 | 0.018 | 0.018 | 0.008 |
| Impact Strength Sample2 (J/mm ²) | 0.008 | 0.018 | 0.010 | 0.021 | 0.018 | 0.010 |
| Impact Strength Sample3 (J/mm ²) | 0.010 | 0.021 | 0.010 | 0.021 | 0.021 | 0.021 |
| Average | 0.009 | 0.021 | 0.009 | 0.02 | 0.019 | 0.02 |

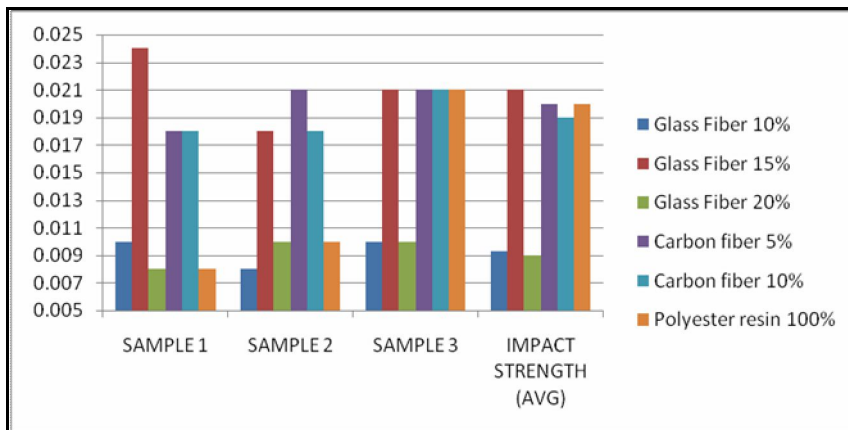


Fig 5 Impact strength graph of the samples

Conclusions

The observed results are showing that GF 20% has greater tensile strength of 0.021 KN/mm² and flexural strength of 0.160 KN/mm². But it shows the low impact strength when compared to GF 15%. In brief, compared to carbon fiber reinforced composite glass fiber reinforced composites are exhibits good mechanical properties. Also the increase in the proportion of the fibers results in increase in the mechanical strength. Polyester resin PR 100% samples exhibit lower mechanical properties when compared to other samples that are tested in this work. It is concluded that the influence of fiber reinforcement will improve the mechanical properties in composites with appropriate proportions.

Nomenclature

GF 10% - 10% of Glass fiber with 90% of polyester resin sample
 GF 15% - 15% of Glass fiber with 85% of polyester resin sample
 GF 20% - 20% of Glass fiber with 80% of polyester resin sample
 CF 5% - 5% of Carbon fiber with 95% of polyester resin sample
 CF 10% - 10% of Carbon fiber with 90% of polyester resin sample
 ASTM – American Society of Testing Materials

Symbols

J – Joules
 KN – Kilo Newton
 KN/mm² – Kilo Newton per millimeter square.

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