# Effect of recycled rubber powder on mechanical and damping behavior of fibre reinforced composite

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**Abstract - This work investigates the effects of recycled rubber powder on tensile and damping behaviour of a woven fabric bi directional composite laminate experimentally. The understanding of mechanical behaviour of composite material is essential for design and application. In Present work mechanical and damping properties of a new class of polymer composite consisting modified epoxy with recycled rubber powder as filler and woven glass fibre as reinforcement. The influences of different volume (0%, 1%, 2%, 4%, 6% and 8%) of the filler material on mechanical properties of the composites were studied. The mechanical characteristics of these composite specimens are experimentally determined using tensile test, flexural test and damping ratio using FFT analyzer as per ASTM standards. The hybrid composite filled with 6% reinforcement show better properties in terms of flexural strength, strength modulus of elasticity and in damping ratio than other composite.**

**Index terms - E-Glass/epoxy, Rubber powder, damping, Hybrid composite.**

## 1.INTRODUCTION

Glass fibre reinforced polymer composites are one of the most widely used composite material. In recent years many fibre reinforced composite materials are widely used in manufacturing various parts in automotive and aerospace industries. Composite materials are markedly superior to those of metallic materials. Fatigue strength –weight ratio as well as fatigue damage tolerance of many composite laminates is excellent. For this reasons fiber reinforced composites have emerged as a major class of structural material and are either used or being considered as substitutions for metals in many weight critical components in aerospace automotive and other industries. As the used tyres which becomes waste product and by burning it could become harm to environment and causes air pollution and also harm to living organisms. It cannot degradable , it can be reused. Powder form of waste rubber tyre can be mixed with fibre in form of filler material to fabricate fibre reinforced composites which improves mechanical and damping properties.

The properties like tensile strength, abrasion resistance and hardness are improved with increase in filler content [1].Mechanical properties of glass fiber reinforced composites with different percentages of fly ash is investigated.[2].Addition of calcium carbonate in epoxy resin improved the impact strength and flexural modulus of the composites [3].Storage modulus is related to the stiffness of composites and damping is associated with the energy dissipation of composites, proved that through toughening of polymer matrix the damping can be improved.[4]. A combined experimental and numerical study of the free vibration of composite GFRP plates has been carried out and performed free vibration analysis of laminated composite beam with various boundary conditions and damping behaviour of composite with various array is investigated.[5].The effect of distribution of resin on vibration characteristics of E lass woven fabric has been studied.[6]. The vibration characteristics of BFRP and GFRP composites at various boundary conditions are compared.[7].The mechanical properties of baggase fiber-caco$_3$ epoxy with different fibre content were evaluated.[8].Disposal of tyre is very large problem after continuous usage for several years.[9]. The performance of new composite material with incorporation of filler material is evaluated.[10].

In present study mechanical and damping properties of different composite material using recycled rubber powder as filler material has been investigated using Universal Testing Machine and FFT analyzer.

## II.MATERIALS AND METHODS

Glass fiber material of bi woven fabric is taken in standard form of 400GSM.These are stacked layer by layer to obtain thickness of 5mm according to ASTM standards. Bonding agent resin is applied to create bonding between layers along with hardener.

| | | |
|---|---|---|
| Type of resin | Epoxy (Araldite LY 556) |  |

<table>
<tr><td>Type of fiber</td><td>E-Glass fiber of bidirectional type</td><td></td></tr>
<tr><td>Hardener used</td><td>HY 951</td><td></td></tr>
<tr><td>No pf plies</td><td>10 each of 0.5 mm thick</td><td></td></tr>
<tr><td>Filler material</td><td>Re cycled Rubber powder in different volumes (0,6,12,24,36,48 gms)</td><td></td></tr>
<tr><td>No of specimens</td><td>06</td><td>
<table>
<tr><td>Specimen</td><td>Fiber volume (%)</td><td>Matrix volume (%)</td><td>Filler material (%)</td></tr>
<tr><td>C1</td><td>60</td><td>40</td><td>0</td></tr>
<tr><td>C2</td><td>60</td><td>39</td><td>1</td></tr>
<tr><td>C3</td><td>60</td><td>38</td><td>2</td></tr>
<tr><td>C4</td><td>60</td><td>36</td><td>4</td></tr>
<tr><td>C5</td><td>60</td><td>34</td><td>6</td></tr>
<tr><td>C6</td><td>60</td><td>32</td><td>8</td></tr>
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</td></tr>
<tr><td>Method of preparation</td><td>Compression technique</td><td></td></tr>
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Table 1 The list of ingredients to prepare composite specimens

**III. FABRICATION PROCESS**

The glass fibre is cut in required shape of the size 200X100 mm of required orientation which weighs approximately 180 gms. To get good surface finish of laminate a thin plastic sheet is used at the top and bottom of the mould. Sufficient amount of resin is prepared and poured over the ply Figure 1 shows the fabrication process . Same process is repeated until the thickness of 5 mm is obtained. Figue 2 shows Six different plates varying volume of rubber powder ( 0%,1%, 2%,4%,6% and 8%) has been prepared.

Fig 1 : Various steps for preparing a composite laminate

| C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|

Fig 2 : Composite plates with different weights of rubber powder.

**IV .DENSITY**

The density of composites of different compositions ASTM test method for density is determined using the mass to volume ratio.

Table 2 Density of specimens

| S No | C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|---|
| 1 | 1.79 | 1.89 | 1.79 | 1.88 | 1.87 | 1.78 |
| 2 | 1.85 | 1.79 | 1.81 | 1.84 | 1.85 | 1.86 |
| 3 | 1.78 | 1.94 | 1.82 | 1.86 | 1.88 | 1.84 |
| 4 | 1.88 | 1.92 | 1.78 | 1.79 | 1.84 | 1.79 |
| 5 | 1.86 | 1.90 | 1.83 | 1.80 | 1.83 | 1.82 |
| Mean ($kg/mm^3$) | 1.83 | 1.83 | 1.80 | 1.82 | 1.85 | 1.81 |

**V.TENSILE & FLEXURAL TESTING**

Figure 3 shows the UTM used for testing The mechanical testing were carried out using an Universal testing machine (9036 TD Sr no STS -22).The specimens are prepared according to ASTM D. Figure 4 shows the specimens.The test was conducted on all specimens to obtain tensile strength and modulus of elasticity. (1mm/min speed). Figure 5 shows the stress strain curve obtained after testing.

*Fig 3 UTM used for tensile and flexural strength*

*Fig 4 Specimens after tensile testing*

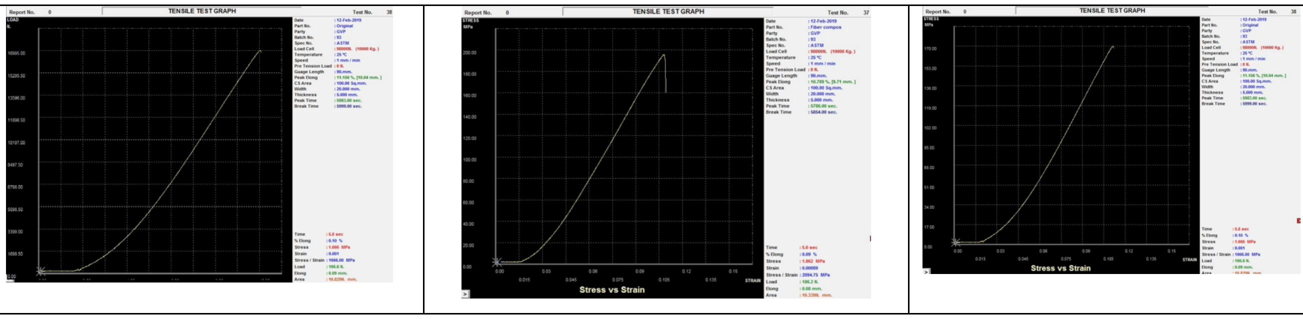


Fig 5 Stress strain diagrams

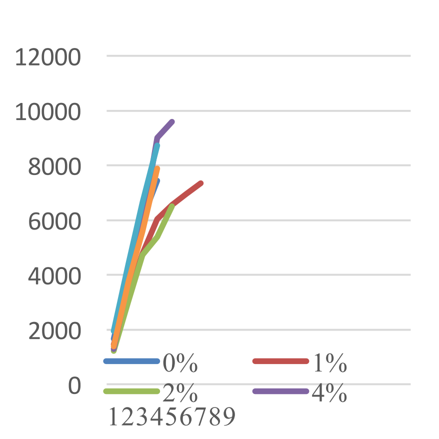


*Fig 6 Load vs deflection curve*

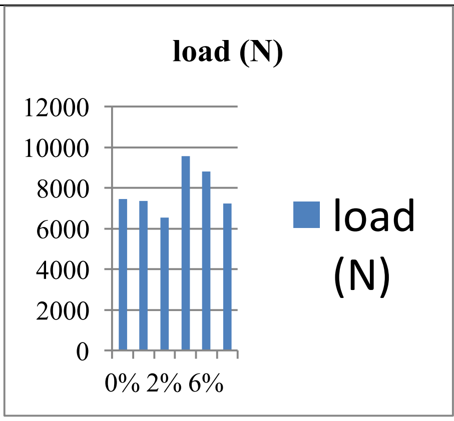


*Fig 7 Bar graph maximum load vs filler volume*

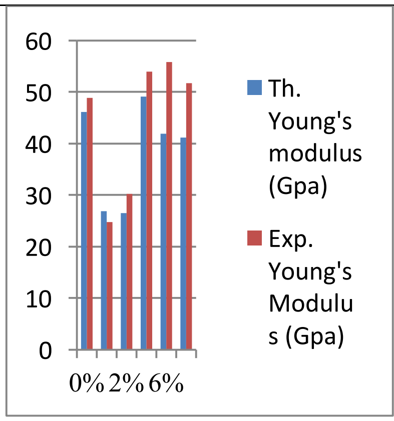


*Fig 8 Bar graph Youngs modulus vs filler volume*

| S no | Property | C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|---|---|
| 1 | E (MPa) | 4.88 | 4.765 | 4.625 | 5.392 | 5.577 | 5.168 |
| 2 | Tensile strength (MPa)) | 950 | 930 | 920 | 1150 | 1851.9 | 1540.6 |
| 3. | Flexural strength (MPa) | 97.26 | 81.03 | 84.14 | 86.23 | 119.56 | 99.4 |

Table 3 shows the experimental values obtained from tensile and flexural tests From table it is observed that value of Tensile strength , Young's modulus and Flexural strength has been increased by modifying matrix with recycled rubber powder. They are found to be more in C5 compared to other specimens.

## VI. DAMPING PROPERTIES

To determine damping parameters such as frequency, amplitude, damping ratio and peak mode values damping test was carried out by using free vibration analysis. Figure 9 shows the damping instrument used in this work.
The damping test carried on Crystal Instruments CoCo-80 Handheld Signal Analyzer. The CoCo-80 is with 2, 4, or 8 input channels which can accurately measures and recorded both dynamic and static signals. The flash memory can record 8 channels of streaming signals simultaneously up to 102.4 kHz. EDM software is a PC software not only for post-processing it also includes FFT spectral analysis, frequency response, octave measurements, and order tracking.

Fig 9 FFT analyzer used for damping test

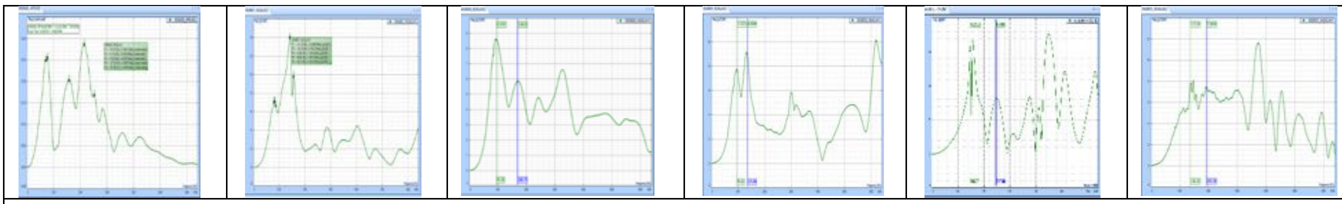

*Fig 10 Experimental data for damping test using FFT analyzer*

Table 4 Frequencies and damping ratio of all composite specimens

| S no. | Specimen | Peak mode Values (Hz) | Amplitude (mm) | Damping ratio (ζ) |
|---|---|---|---|---|
| 1 | C1 | 214.38 | 0.25 | 0.058 |
| 2 | C2 | 155.63 | 9.79 | 0.048 |
| 3 | C3 | 168.75 | 5.8623 | 0.085 |
| 4 | C4 | 135.00 | 8.9509 | 0.0629 |
| 5 | C5 | 246.88 | 8.2483 | 0.09 |
| 6 | C6 | 192.50 | 7.3870 | 0.029 |

**CONCLUSIONS**

A new class of composite materials have been developed by using rubber powder as filler material and following observations are made

1. Environmental waste such as used rubber tyres were utilized to develop fibre reinforced composite.
2. The Elastic modulus in specimen with of 6% rubber powder as filler material is found to be 14% higher than that of Unmodified e-glass fibre.
3. The flexural strength of 6% rubber powder as filler material is 25% higher than that of unmodified fibre.
4. The damping ratio of 6% rubber powder a filler material is 80% higher than that of E –glass fibre without filler material.
5. This composite finds use in the areas which desire good flexural strength, high yield strength and good damping to absorb shock loads for automotive components.

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