Characterization of Glass Fiber Reinforced Polymer Materials

1 Session Objectives
   a) Familiarize with the concepts GFRP materials.
   b) Understand the basic principles of mechanical property development in fiber reinforced polymers (FRP).
   c) Experience the measurement of tension properties on GFRP.

2 Study Material

Based on the readings provided, answer the following questions:

1) Explain, in simple words, the concept of a composite material; and why composite material show superior properties to each of its components.
2) Explain how you would built and use a leaky mold to fabricate tensile test samples.
3) Explain how you would built large storage tank based on FRP.
4) Explain how mass produced automotive outer panels for the Chevrolet Corvette are manufactured.
5) Determine the theoretical properties for a standard 30 vol% E Glass (chopped strand mat) / Polyester:
   a. Modulus of elasticity E
   b. Tensile strength TS
   c. Fracture toughness Gc
6) Determine the theoretical properties for a standard 30 vol% E Glass (woven fabric) / Polyester:
   a. Modulus of elasticity E
   b. Tensile strength TS
   c. Fracture toughness Gc

1 Print out this document and fill-in the requested information by hand using pen (ink). The Study Material Questions (5.1) needs to be filled in before your arrival at the lab.
3 Material & Equipment

3.1 Materials
1) 4 standard FRP samples of different configurations for tensile testing\(^2\)
   a. 30 vol% E Glass (chopped strand mat) / Polyester at 0°
   b. 30 vol% E Glass (chopped strand mat) / Polyester at 45°
   c. 30 vol% E Glass (woven fabric) / Polyester at 0°
   d. 30 vol% E Glass (woven fabric) / Polyester at 45°

3.2 Tools & Equipment
1) 6 inch digital caliper
2) 2 inch sample scribing tool
3) Universal testing machine (with standard tensile testing grips)

4 Procedure
1) The instructor will explain the operation of both the universal testing machine when testing composites.
2) With the help of an instructor, students will perform the tensile tests on the 4 samples provided.
   a. Measure each sample carefully before testing
   b. Running the test
   c. Measuring each sample carefully after testing
3) The students will analyze the results obtained and will fill the questions in the report section.
4) Students will record their results on the corresponding flipchart.

\(^2\) Materials may change based on availability.
5 Report

5.1 Study Material Questions

1) Explain, in simple words, the concept of a composite material; and why composite material show superior properties to each of its components.

2) Explain how you would built and use a leaky mold to fabricate tensile test samples.
3) Explain how you would built large storage tank based on FRP.

4) Explain how mass produced automotive outer panels for the Chevrolet Corvette are manufactured.
Determine the theoretical properties for a standard 30 vol% E Glass (chopped strand mat) / Polyester:
   a. Modulus of elasticity \( E \)
   b. Tensile strength \( TS \)
   c. Fracture toughness \( G_c \)
6) Determine the theoretical properties for a standard 30 vol% E Glass (woven fabric) / Polyester:
   a. Modulus of elasticity $E$
   b. Tensile strength $TS$
   c. Fracture toughness $G_c$
## 5.2 Testing Procedure

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Overall Process, Precaution, Do's &amp; Do Not's</th>
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<tbody>
<tr>
<td>Universal Testing Machine</td>
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<tr>
<td>Tensile Test Grips</td>
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<tr>
<td>Extensometer</td>
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<tr>
<td>Sample Scribing Tool</td>
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<td>Vernier Caliper</td>
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</tbody>
</table>
5.3 Measurements

<table>
<thead>
<tr>
<th>Property</th>
<th>30 vol% E Glass (CSM) / Polyester 0°</th>
<th>30 vol% E Glass (CSM) / Polyester 45°</th>
<th>30 vol% E Glass (WF) / Polyester 0°</th>
<th>30 vol% E Glass (WF) / Polyester 45°</th>
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</thead>
<tbody>
<tr>
<td>Sample Thickness (initial/final)</td>
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<tr>
<td>Sample Width (initial/final)</td>
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<td>Sample Length (initial/final)</td>
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<tr>
<td>Young Modulus</td>
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<tr>
<td>Yield Strength</td>
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<tr>
<td>Tensile Strength</td>
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<tr>
<td>Elongation in ___</td>
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<tr>
<td>Reduction in ___</td>
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<tr>
<td>Sketch of the fracture area of the sample</td>
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</tbody>
</table>

5.4 Results Interpretation

a. Which of the materials used is the strongest?

b. Which of the materials used is the most rigid?
c. Sketch the strain-stress curves for each material into the chart below. Make sure to keep the proportions right.
From the stress tests carried out, what noticeable differences are observed between the mechanical properties of random vs. oriented fiber materials?

6 Conclusions
Briefly explain your personal “take-away” from this lab session.

I, __________________________ declare that this laboratory report for the Characterization of Glass Fiber Reinforced Polymer Materials session is of my authorship and responsibility. The document was turned-in for grading on: ________________.

Date _______________________

Signature ___________________