

## Accelerated Aging Response of Carbon Composites Under Tension and Bending

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### ABSTRACT

An accelerated aging method was developed to evaluate losses in mechanical properties in carbon composite materials. Carbon fiber reinforced polymer (CFRP) composite coupons were tested under tension and bending to establish their strength and stiffness. After accelerated environmental conditioning reductions in mechanical properties in mechanical properties of CFRP were established, and preliminary calibration was carried out using natural degradation rate of CFRP materials. The maximum reduction in these values after accelerated aging was found to be 7%. The aged CFRP material followed a reduction rate that corresponds to a typical inverse exponential curve.

**KEY WORDS :** CFRP, composite, strength, stiffness, tension, bending, degradation

### INTRODUCTION

This paper explores the rate of degradation in mechanical properties of carbon fiber reinforced plastic (CFRP) plates under accelerated aging conditions. Characteristically, these CFRP plates are lightweight and have extremely high strength and stiffness, excellent fatigue properties, and outstanding corrosion resistance [Meier and Kaiser, 1991]. The literature reviews dealt with the effect of environment on fiber reinforced polymer (FRP) composites and adhesives.

More specifically, the goals of this investigation are: to establish rate of degradation of strength and stiffness of the CFRP material (manufactured in cooperation with Creative Pultrusions Inc.) under an accelerated aging procedures, and to establish mechanical fatigue effects on the CFRP material.

A total of seventy two coupons were prepared for coupon level testing. Thirty six 1" x 12" 3/16" coupons were prepared for static tension tests and referred to as tension specimens. Four of the thirty six specimens were left unconditioned and used as base values for comparison with the conditioned tension specimens. Additional thirty six coupons were prepared for coupon level three point bending tests and are referred to as bending specimens. Following ASTM D 790 - Standard Test Methods for Flexural Properties of

Table 1 Conditioning variations for tensile and bending coupon specimens

Number of Replications	Thermal Condition	Duration	Environment
4 - Tension 4 - 3 pt. Bending	Constant - 150°F	90	Thermal Chamber
4 - Tension 4 - 3 pt. Bending	Constant - 150°F	90	3% NaCl Solution
4 - Tension 4 - 3 pt. Bending	Constant - 150°F	180	Thermal Chamber
4 - Tension 4 - 3 pt. Bending	Constant - 150°F	180	3% NaCl Solution
4 - Tension 4 - 3 pt. Bending	Cyclic- as in fig. 2	90	Thermal Chamber
4 - Tension 4 - 3 pt. Bending	Cyclic-as in fig. 2	90	3% NaCl Solution
4 - Tension 4 - 3 pt. Bending	Cyclic-as in fig. 2	180	Thermal Chamber
4 - Tension 4 - 3 pt. Bending	Cyclic-as in fig. 2	180	3% NaCl Solution

Unreinforced and Reinforced Plastics and Electrical Insulating Materials, the bending specimen dimensions were established to be 9 1/2" x 1/2" x 3/16". Four of these specimens were left unconditioned to provide base values for comparison with the conditioned bending specimens. Sixty four coupon specimens, both to be tested under tension and bending, were conditioned with the following variations:

1. Constant 150°F temperature for 90 days
2. Constant 150°F temperature soaked in 3% NaCl solution for 90 days
3. Constant 150°F temperature for 180 days
4. Constant 150°F temperature soaked in 3% NaCl solution for 180 days
5. Varying temperature and humidity for 90 days
6. Varying temperature and humidity soaked in 3% NaCl solution for 90 days