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# Flexural creep tests and long-term mechanical behavior of fiber-reinforced polymeric composite tubes

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**Abstract**

An experimental investigation of the long-term creep behavior of fiber reinforced polymeric composite tubes subjected to flexural loading was performed. The tubes were first tested under a three-point bending scheme at room temperature to determine the ultimate flexural strength (UFS) and to identify the characteristic failure mode and possible failure locations. Creep tests were then carried out at stress levels of 45%, 55%, 65%, and 75% of the UFS at constant temperatures ranging from -60°C to 100°C for 500 hours, and strain measurements over time were recorded. The tubes were further tested at varying temperatures by applying 22.5 thermal cycles between -60°C and 100°C and 9.5 thermal cycles between -160°C and 80°C. Similar flexural loads were applied simultaneously on the tubes. Long-term creep deformation of the tube was evaluated using the time-temperature-stress superposition principle, the derived creep main curves, and the Findley model. Finally, the creep deformation and mechanical strength of the tube at expected service conditions over its entire lifetime were predicted.

**Keywords:** Polymer matrix composites, creep deformation, flexural strength, mechanical behavior

## 1. Introduction

Fiber-reinforced polymeric (FRP) composites are increasingly used in the aerospace industry, e.g., in space satellite antennae. Typically, these kinds of structural elements are exposed to environmental conditions such as high and low temperatures, or cyclic variations of temperature. To fulfill the requirements of deep space exploration, the elements need to carry certain mechanical loads under rather wide temperature variations and operate for long durations, typically more than ten years. Naturally, their short-term and long-term durability and structural integrity are of great concern. According to contemporary research from Scott and Lai [1], Narin [2], Fllyin and Rohrbacher [3], Sanders [4], Ray [5], Sethi, and Ray [6], FRP composites, such as carbon fiber and epoxy matrix composites, are sensitive to temperature variations [7] and their mechanical behavior is strongly influenced by temperature [5]. Exposure to low temperatures may cause a plastic to become brittle, which may induce cracking and a propensity to fracture.