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Prediction of failure of 3D woven composite structures using embedded fiber optic sensors

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Abstract

Fiber optic is widely used in data communications. They established themselves in communicating images, voices and data that are useful in applications such as telephone communication, radio and television broad casting, and computer networking. The use of fiber optic as embedded sensors in textile structures is relatively new and research in this area is mounting due to its potential applications. Research examples using embedded optic fibers in textile structures include predicting stress distribution on parachute structures during opening and descending and wound location of injured army personnel.

Today, many structures from reinforced fiber composites are used in constructing planes, bridges, ships, boats, automotive, windmills, and constructions. Since fiber optic can be easily incorporated in such structures, they provide opportunities of using them as sensors to predict failure of structure elements. The overall objective of this research is to develop smart textiles. This paper addresses the need for a system by which assessment of fiber optic deflection in bending mode could predict failure of structures with embedded fiber optic. We developed a system consisting of a Helium-Neon laser beam with power of 20 mw (milliwatt), and power detector to measure power loss due to fiber optic deflection in 3-point bending mode. The power loss is obtained by comparing the laser power transmitted through deflected sensor compared to the power transmitted through straight sensor. The power loss of two types of fiber optic (MFD 62μ and MLD 100μ) at different deflections and span lengths were determined. The data will be compared to failure data of composite structures and results will be reported in future publication.

Key words: *3D woven composites, Fiber optic sensors, Laser, Power loss, 3-point bending*

1. Introduction

High maintenance, heavy weight and corrosion of steel have opened research areas to replace steel with fiber reinforced composite (FRC). Composite materials are known to be stronger, lighter than steel and resistant to corrosion. For example, composite pipe with 15 centimeters diameter weighs 1.8 kg/meter is much stronger, compare to cooper nickel pipe with the same diameter weights 10.8 kg/m. These advantages of composite material have opened the door for composite

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