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Abstract

Development of Self-Sensing Carbon Nanotube-Based Composites for Civil Infrastructure Applications †

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Worldwide, civil infrastructure systems are aging and deteriorating due to maintenance neglect, increasing traffic, and an environment that is becoming increasingly more severe. In particular, bridges play a critical role in the transportation network. With limited monies available for maintenance and repair, a need exists for effective yet inexpensive solutions to strengthen and monitor bridges. This presentation provides an overview of the development of carbon nanotube (CNT)-based composites, which offer a means to strengthen and monitor a deteriorated bridge member simultaneously. CNT sensors are created by infusing a fabric, which can be structural or non-structural, with carbon nanotubes to form a piezo-resistive network. Changes in the measured resistance between electrodes, which are attached to the composite layer, have been found to directly correlate to deformations and the formation and accumulation of internal damage. The resulting novel self-sensing composites are sensitive, inexpensive, and able to adhere to almost any shape. Two particular civil infrastructure applications will be presented and discussed in detail. First, two large-scale reinforced concrete beams were strengthened with a composite layer that had an embedded sensing layer and then loaded to failure using load cycles of increasing amplitude. The objective of the second application was to increase the remaining fatigue-life of a cracked steel bridge member. For this application, ASTM E647 test specimens were rehabilitated with self-sensing composites and loaded cyclically to failure. Both applications highlight the potential of CNT-based composites in bridge rehabilitation and monitoring.