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A Thermographic and Energy Based Approach to Define High Cycle Fatigue Strength of Flax Fiber Reinforced Thermoset Composites

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Abstract : Fiber-reinforced polymer matrix composites have a wide range of applications in the sectors of automotive, aerospace, sports utilities, among others, due to their high specific strength, stiffness as well as reduced weight. In addition to those favorable properties, composites composed of natural fibers and bio-based resins (i.e., biocomposites) have eco-friendliness and biodegradability. However, the applications of biocomposites are limited due to the lack of knowledge about their long-term reliability under fluctuating loads. In order to explore the long-term reliability of flax fiber reinforced composites under fluctuating loads through high cycle fatigue strength (HCFS), fatigue test were conducted on unidirectional flax fiber reinforced thermoset composites at different percentage loads of ultimate tensile strength (UTS) with a loading frequency of 5 Hz. Change of temperature of the sample during cyclic loading was captured using an IR camera. Initially, the temperature increased rapidly, but after a certain time, it stabilized. A mathematical model was developed to predict the fatigue life from the data of stabilized temperature. Stabilized temperature and dissipated energy per cycle were compared with applied stress. Both showed bilinear behavior and the intersection of those curves were used to determine HCFS. HCFS for unidirectional flax fiber reinforced composites is around 45% of UTS for a loading frequency of 5Hz. Unlike fatigue life, stabilized temperature and dissipated energy-based models are convenient to define HCFS as they have little variation from sample to sample.

Keywords : energy method, fatigue, flax fiber reinforced composite, HCFS, thermographic approach
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