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Abstract

Bamboo, as a natural functionally-graded (FG) bio-composite material, exhibits excellent load-bearing properties, such as flexibility and fracture toughness. In construction field or other load-bearing applications, bamboo along with bamboo-based structural materials are often subjected to cyclic loading. However, works in the current literature are rarely associated with the fatigue behavior of this biomaterial. The present work emphasizes on the evaluation of the flexural fatigue behavior of bamboo strips under different loading configurations. Results showed that the gradient distribution of the vascular bundles along the thickness direction is mainly responsible for the exhibited anisotropic fatigue response, including fatigue life, hysteresis loops and residual stiffness. Based on the *in situ* observation and fracture morphology analysis, the hierarchical fiber/foam-like parenchyma cells (PCs) plays a critical role in alternating the key factors for determining the remarkably different crack propagation mechanisms. A two-parameter Weibull function was used to evaluate the failure probability of bamboo strips subjected to flexural loading. Likewise, in order to quantitatively assess the relationship between the extension of damage and number of cycles, an analytical model in terms of residual stiffness has been proposed. Lastly, we expect that this work could serve as the guideline to assist the raw bamboo materials and bamboo-based composites into many other structural engineering applications.

Keywords: bamboo; fatigue behavior; *in situ* flexural bending test; fatigue failure model; micromechanics

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