A Review of Fiber Reinforced Plastic Laminated Structures for more Efficient and Clean Transportation

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Abstract

Laminated composite materials are a lighter and of customizable flexibility material alternative for road vehicles. FRP laminated structures in the automotive industry may be an ideal solution for lighter and safer vehicles, while the weight reduction is also associated with lower fuel emissions. In this paper, we investigate the behavior of laminated FRP structures under bending and more specifically how the number of layers and stacking sequence of the structures affect their performance. A theoretical approach to the design of such structures, more specifically laminated FRP beams under cyclic bending, is presented in the first part of the review. The design of FRP laminates is based on Classical Lamination Theory (CLT) and interactive failure theories. The second part of the review examines the potential of FRP laminated structures to become the host of piezoelectric fibers and be used as energy scavenging devices, while maintaining their desirable and tailored stiffness and high performance, at a low weight. Two examples where laminated FRP beams are used as the host of piezoelectric layers to produce energy scavenging structures are presented. These examples examine beam structures under cyclic loading where the fiber stacking sequence allows for tailoring of the degree of deformation under bending. The deformation affects the amount of energy produced as the electromechanical behavior of the piezoelectric layer is guided by the mechanical behavior, more specifically deflection under a bending moment, of the FRP structure. The fiber material in each example addresses a different possible application area: E-glass fibers for applications where moisture effects may be a concern, and natural fibers in those where moisture effects are negligible.

Keywords: *Fiber Reinforced Plastics (FRP), Classical Lamination Theory (CLT), Interactive Failure Theories, Piezoelectric Fibers, Energy Scavenging.*

Short biography

Roselita Fragoudakis is an Assistant Professor in Mechanical Engineering at Merrimack College in North Andover, Massachusetts, USA. Her research is on materials. Dr. Fragoudakis has worked on a comparison of steel and Fiber Reinforced Plastic (FRP) applicable in heavy duty vehicle suspension systems. She has conducted experimental and computational analysis on Lateral Diffused Metal Oxide Semiconductor (LDMOS) packages and the dielectric properties of polymers. Currently she directs computational analysis of fiber orientations around geometric discontinuities. Additionally, she investigates ethical dilemmas in the innovative technological advances in her field and has created a course exploring the ethics of innovation and matters of intellectual property. Dr. Fragoudakis has served as a reviewer on multiple journals and periodicals, including the International Journal of Fatigue and Mechanics of Advanced Materials and Structures.

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