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Experimental and Computational Analysis of Glass Fiber Reinforced Plastic Beams with Piezoelectric Fibers

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Abstract : This study investigates the behavior of Glass Fiber Reinforced Plastic (GFRP) laminated beams additionally reinforced with piezoelectric fibers. The electromechanical behavior of piezoelectric materials coupled with high strength/low weight GFRP laminated beams can have significant application in a wide range of industries. Energy scavenging through mechanical vibrations is the focus of this study, and possible applications can be seen in the automotive industry. This study examines the behavior of such composite laminates using Classical Lamination Theory (CLT) under three-point bending conditions. Fiber orientation is optimized for the desired stiffness and deflection that yield maximum energy output. Finite element models using ABAQUS/CAE are verified through experimental testing. The optimum stacking sequences examined are [0o]s, [0/45o]s, and [45/-45o]s. Results show the superiority of the stacking sequence [0/45o]s, providing higher strength at a lower weight, and maximum energy output. Furthermore, laminated GFRP beams additionally reinforced with piezoelectric fibers can be used under bending to not only replace metallic component while providing similar strength at a lower weight but also provide an energy output.

Keywords : classical lamination theory (CLT), energy scavenging, glass fiber reinforced plastics (GFRP), piezoelectric fibers
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