Wavelet-Based Damage Detection and Localization in Laminated Composites Using Numerical Homogenization

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ABSTRACT

This study presents a novel method for detecting damage in laminated composite plates, combining numerical homogenization [1] and wavelet analysis [2] to assess and localize structural damage. In this approach, a numerical model incorporating homogenization techniques is employed to simulate the behavior of a laminated composite plate with delamination between its layers. The model focuses on identifying weakened material parameters at sites of damage by accurately representing the laminate's structure, including the discontinuities characteristic of delamination, which are crucial for capturing the effects of damage on the laminate's mechanical properties. By applying Discrete Wavelet Transform (DWT) techniques [3], the method effectively detects and localizes the damage, leveraging the model's ability to distinguish between undamaged and damaged states through variations in material parameters. The numerical homogenization process [4] is designed to account for the 3D characteristics of the laminated composite, ensuring that the Finite Element (FE) model [5] can accurately reflect the complex interactions within the laminate's structure, including the effects of transverse shear and bending stiffnesses. This comprehensive modeling technique offers a powerful tool for Structural Health Monitoring (SHM), enabling detailed assessment of damage within laminated composites and facilitating the development of more effective maintenance strategies and structural designs.

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