DYNAMIC ASSESSMENT OF THICK SANDWICH BEAMS USING A MIXED-REFINED ZIGZAG THEORY: EXPERIMENTAL VALIDATION USING LASER DOPPLER VIBROMETRY

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ABSTRACT

This work presents a numerical and experimental dynamic assessment of thick sandwich beams using a mixed-Refined Zigzag Theory ($\text{B-RZT}_{\{3,2\}}^{(m)}$) and the Laser Doppler Vibrometry. Sandwich beams, composed of a core material sandwiched between two face sheets, are commonly used in various engineering applications due to their lightweight and high stiffness properties [1]. However, their distinct material compositions often result in pronounced transverse shear deformations, and in the case of thicker beams, additional transverse normal deformations. In the literature [2], various numerical models exist to evaluate numerically frequencies and modal shapes of thick multilayered sandwich beams. Among them, the recently developed mixed-higher-order en-RZT [3] has demonstrated exceptional accuracy in predicting the static response of thick multilayered composite and sandwich plates compared to three-dimensional analytical solutions.

Although numerous numerical examples exist in the literature, very few experimental results concerning the modal parameter estimation of thick sandwich structures are available. In fact, thick structures typically exhibit higher frequencies; thus, from a practical standpoint, hammer tests are not the most suitable option. Laser Doppler Vibrometry (LDV) is a non-contact technique used to measure the vibrational characteristics of structures by analysing the Doppler shift of laser light reflected from the structure's surface at appropriate points. This methodology avoids mass loading and installation problems typical of accelerometers and improves the spatial resolution of possible measuring points.

In this experimental-numerical study, a series of thick sandwich beam specimens of different thicknesses, made of ERGAL face-sheets and Rohacell® WF110 core, are dynamically investigated. An experimental modal analysis campaign using the LDV technique is conducted to evaluate the modal parameters of the sandwich beam specimens in a frequency bandwidth from 400 Hz to 4 kHz. Free-Free boundary conditions are considered, whereas an electrodynamic shaker is adopted to apply the excitation force as a period chirp of constant amplitude.

The experimental results concerning natural frequencies, modal shapes and damping parameters obtained from LDV measurements and elaborated using the PolyMax algorithm are compared with the theoretical predictions for the flexural modes based on a finite element beam model developed on the mixed-Refined Zigzag Theory ($\text{B-RZT}_{\{3,2\}}^{(m)}$).

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