FREE VIBRATION ANALYSIS OF SANDWICH BEAMS USING THE REFINED ZIGZAG THEORY: AN EXPERIMENTAL ASSESSMENT

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ABSTRACT

Over the last decades, multilayered composite and sandwich structures have been increasingly used in several engineering fields, ranging from military and civilian aircrafts to aerospace vehicles, from naval to civil structures. The main reason for this success lies in the high stiffness-to-weight and strength-to-weight ratios and in the possibility to tailor the mechanical properties according to the specific application. Sandwich structures show further remarkable characteristics in terms of impact energy absorption and noise reduction.

Accurate response predictions are required for sandwich structures, inherently characterised by high transverse deformability and anisotropy at an extent that makes classical lamination theories inadequate. The open literature presents several approaches and theories for the analysis of sandwich structures, those referred to as Equivalent Single Layer (ESL) theories (computationally affordable but less accurate) [1] and the so-called Layer Wise (LW) theories (highly accurate but computationally more demanding) [2]. The zigzag class of theories, pioneered by Di Sciuva [3], represents an interesting compromise between accuracy and computational cost. The recently presented Refined Zigzag Theory (RZT) [4] has been demonstrated to be highly accurate both in terms of global responses (maximum deflection, natural frequencies, buckling loads) and of local distributions (displacements and stresses along the thickness) of sandwich structures [5].

Aim of the present work is to further investigate the modelling capabilities of RZT for the analysis of sandwich beams and to cover one of the weak points of the open literature, i.e., the very limited number of experimental tests used to provide reference for lamination theories assessment [6]. The focus of the study will be on free vibrations and will be organized as follows. A very short review of RZT basic hypotheses and equations will be presented, with particular attention to the linear eigenvalue problem of free vibrations. Then an experimental campaign will be discussed; natural frequencies and mode shapes will be evaluated for some sandwich beams with aluminium faces and foam cores (different span-to-thickness ratio and face-to-core stiffness ratio). A final comparison between experimentally-evaluated and RZT-predicted free vibration responses will be performed to show the accuracy of RZT.

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