Zigzag theories for composite laminates and sandwich structures

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Abstract

An increasing number of primary load-bearing structures, not only in the aerospace industry, but also in the automotive, nuclear, naval and civil constructions, are made of relatively thick composite laminates and sandwich structures. As reliable design and failure predictions require accurate estimates of local stress states, affordable computational costs for these structures are the main concern. As computational costs of 3D models as well as Layer-wise (LW) models increase with the number of layers, it is evident the strong interest for 2D models able to take into account the layered nature of the composite laminates and sandwich structures, while preserving the affordable computational cost of the Equivalent Single Layer (ESL) models.

To date, the best candidates appears to be the Zigzag models. In fact, they have a fixed number of unknowns (the same as ESL), allow for the distortion of the cross-section and satisfy the interface continuity conditions. So, their computational cost is comparable to that of ESL models while their computational accuracy is comparable to that of LW models.

Aim of this Lecture is to give a review and some new accomplishments of the displacement-based zigzag theories for laminated composite and sandwich structures, with special emphasis on the underlying ideas, relative strengths and weaknesses.

The Lecture is organized as follows. First, the motivation and technical challenges for accurate analysis of multilayered structures are discussed. After, the basic ideas on which rests the Di Sciuva’s zigzag theory are presented. This will serve as a starting point for introducing some further achievements of the theory and a recent version, known as the Refined Zigzag Theory (RZT). Also included is a comparison of this theory with the Murakami’s Zigzag theory, which shares with RZT the same kinematics, but different zigzag functions. The Lecture ends with the presentation of some numerical results and the conclusions..