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Contributions to Modernizing Experimental Hygrothermal Determinations in Constructions

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Summary

The main purpose of the PhD thesis is to study the influence of the principal parameters of the composite laminas on the stiffness and strength properties of the laminated composites. Moreover, the intralaminar and interlaminar failure modes are investigated, with respect to the properties of the corresponding layers. As a result of the investigation of the main parameters influencing the variation of the mechanical characteristics of the laminates, a series of rational stacking sequence configurations are designed, in order to accurately satisfy the needed stiffness and strength design requirements, taking also into account the total cost of the constituent materials.
Another objective of the work consists in the analysis of the flexural behaviour of the sandwich beams, studying the contribution of the exterior layers, as well as the influence of some core parameters, on the overall mechanical characteristics.
The first three chapters are dedicated to introduction, to the presentation of the theoretical aspects regarding the micromechanics and macromechanics of the composite lamina, as well as the macromechanics of the composite laminates.

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In chapter 3, contributions are made regarding the development of new matrix form relations for the evaluation of the in-plane and flexural engineering constants, valid for any general case of composite laminates.
In chapter 4 are presented several studies related to the influence of the main parameters of the composite laminas on the stiffness and strength properties of laminated composites. The influence of the fibre volume fraction, fibre orientation angle and stacking sequence on the mechanical characteristics of different configuration composite laminates is investigated. The evaluation of the in-plane and flexural elastic properties of the multi-layered composites is performed according to the relations developed by the author.
An intralaminar progressive failure analysis is carried out, in order to identify the mechanical behaviour of composite laminates subjected to different loading actions. Moreover, a post-critical damage analysis is performed, as to describe an accurate damage distribution on the layers with different fibre orientation angle of the multi-layered composites, from the damage onset to the complete collapse.
Chapter 6 presents the interlaminar failure analysis of four specially orthotropic symmetric multi-layered composites (cross-ply, angle-ply, balanced and quasi-isotropic composite laminates). Therefore, there are investigated the crack tip opening displacement, the distribution of the equivalent stresses and the interlaminar stresses on the layers of the laminates, for an imposed initial displacement in mode I of fracture or in opening mode. Moreover, the evolution of delamination is analysed until the final separation. An important studied parameter is represented by the influence of the fibre orientation of the adjacent layers on the crack tip opening displacement evolution.
In chapter 7, a case study is realised on six variants of balanced composite laminates, with same stacking sequence, but made of different composite materials, in order to choose the adequate solution in terms of mechanical properties and total cost of the constituent materials. As to improve these aspects, two of the analysed composite laminates are considered hybrid multi-layered composites.
Chapter 8 refers to the investigations of the influence of the corresponding layers properties on the mechanical characteristics of the sandwich beams, and the last chapter summarize the general conclusions, personal contributions and dissemination of the research results.

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