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SIMULTANEOUS SIZE/ MATERIAL OPTIMISATION AND ACCURATE ANALYSIS OF COMPOSITE STIFFENED PANELS

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Abstract: *this work deals with the problem of the least-weight design of a composite stiffened panel. The design problem is stated as a constrained non-linear programming problem (CNLPP). Optimisation constraints of different nature are considered: mechanical constraints on the admissible material properties of the laminates as well as on the global buckling load of the panel, geometrical and manufacturability constraints on the geometric design variables of both the skin and the stiffeners.*

To face such a problem a multi-scale two-level (MS2L) design methodology is proposed. The MS2L design method aims at optimising simultaneously both the geometrical and the material parameters for the skin and the stiffeners at each characteristic scale (meso and macro scales). The MS2L optimisation strategy relies on the one hand on the utilisation of the polar parameters (in the framework of the equivalent single layer theories) for describing the macroscopic behaviour of each laminate composing the panel (both skin and stiffeners) and on the other hand on a special hybrid algorithm (genetic algorithm + gradient-based algorithm) in order to perform the solution search for the problem at hand.

In this background, the design problem is split into two different (but related) optimisation problems. At the first level (macroscopic scale) the goal is to find the optimum value of the geometric and material (i.e. the polar parameters) design variables of the panel minimising its mass and meeting (simultaneously) all the requirements provided by the technical specification (i.e. the optimisation constraints) for the problem at hand. The second-level problem focuses on the laminate mesoscopic scale (i.e. the ply-level). Here the goal is the determination of at least one stacking-sequence (for each laminate composing the panel) meeting the optimum value of both the material and geometrical design variables provided by the first-level problem.

The effectiveness of the new, non-classical configurations will be verified a posteriori through a refined finite element model of the stiffened panel making use of elements with different kinematics and accuracy (in a global-local sense) in the framework of the Carrera Unified Formulation (CUF).