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# DESIGN OF A COMPOSITE STRUCTURE WITH MANUFACTURING CONSTRAINTS

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**Abstract:** Composite structures are mechanical structures composed of fibers (carbon) and resin. In the recent years, composite structures have taken a growing importance in the aeronautical industry. Because they exhibit high performance properties and lead to a considerable weight reduction, they can be an alternative choice in the design of many aircraft parts. The paper presents a methodology to design such structure. A composite structure is made of a stacking of plies and the fibers in each ply can be oriented in a specific direction (0°, 45°, 90° and 135°). If the structure is divided into zones, the design variables will be the number of plies per orientation per zone. The mechanical performance of the structure depends on the total number of plies and the percentage of plies per orientation in each zone. The objective is to reduce its weight while satisfying some structural integrity constraints. Moreover the stacking sequence of the plies must also satisfy some manufacturing rules. These constraints are of combinatorial nature with respect to the design variables. A stacking sequence generator is used to compute admissible stacking sequences with respect to these rules and which correspond to the design variables. Given that an admissible stacking sequence does not exist for every set of values of the design variables, a repair operator is proposed to cope with this problem. It aims at changing the values of the number of plies in each orientations in order to guarantee the existence of admissible stacking sequences with respect to the manufacturing rules. The approach to solve this optimization problem using a surrogate based genetic algorithm. A repair operator, which is the main focus of the talk, is presented to handle the manufacturing rules. An engineering application is presented to show the advantages of this approach in terms of constraint satisfaction and computational time. The application represents the design of an aircraft wing. The objective function is the weight of the wing. The constraints are the stability of the wing, the Tsai-Wu failure criteria and the manufacturing rules which are handled by the proposed repair operator.