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Title

Optimal Design of Three-Dimensional Woven Composites Aircraft Wing with Genetic Algorithm

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Abstract

The three-dimensional woven composite has great production speed, excellent formability and outstanding utilization by the automated manufacturing process based on the preform. In addition, it has high out-of-plane mechanical properties due to the three-dimensional fiber arrangement. The wings of aircraft should have sufficient mechanical properties and should not fail, but at the same time they should be lightweight. Through the optimal design, it is possible to design the aircraft wings in three-dimensional woven composite with mechanical properties that do not fail and minimum mass.

In this paper, the optimal design was performed using a genetic algorithm in order to reduce the weight of the aircraft wing in three-dimensional woven composite. An objective function is to minimize the weight of the aircraft's wing. Design variables were set on the number of fill yarn layers, making up the skins, spars and ribs of the wings. As the stringers are an integral part of the skins, they depend on the number of fill yarn layers in the skins. A population is formed with the set design variables and the fitness of each chromosome is evaluated in each generation. According to the evaluation result, the chromosomes that will survive in the next generation are selected by a selection operation. The selected chromosomes generate the next generation by crossover operation and apply the mutation operation to prevent the whole generation from falling into the local optimal solution. The mechanical properties of the wing's each part are defined by the chromosomes of the generated offspring. Failure analysis is performed based on the Tsai-Wu's failure theory. The presence or absence of failure is specified as a constraint. Chromosomes that do not meet the constraint are excluded. And iterates until it converges to the minimum mass. Through the optimal design preformed in this paper, we can build a database of mechanical properties and the mass of the aircraft's wing according to the number of fill yarn layers.