AN IMPROVED SHEPARD’S METHOD FOR OPTIMIZATION OF COMPOSITE STRUCTURES

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Summary. A new multi-point structural approximation scheme based on Shepard’s method is proposed for stacking sequence optimization of laminates. A complete optimization strategy is presented that enables important reduction of the computational effort together with good accuracy of the results.

Stacking sequence optimization of laminated composite structures is a combinatorial problem involving discrete variables when ply angles are used directly as design variables. Such an optimization problem can be solved efficiently using genetic algorithms (GA) coupled with response surface methods to reduce the computational cost. Alternatively, the optimization problem can be formulated using lamination parameters as design variables. Lamination parameters efficiently define the stiffness of a laminate with a minimum number of continuous variables. Indeed, the total number of variables per laminate is independent of the number of layers. Efficient gradient-based optimization methods can be used to solve the problem even when numerous laminates are designed simultaneously, making it possible to tackle problems that are otherwise intractable to GA because of the excessive dimension of the design space. After continuous optimization has been performed it is necessary to reconstruct practical stacking sequences. This recovery procedure can be problematic since finding a practical stacking sequence that exactly matches the continuous solution may not be possible. An extensive review of composite optimization can be found in [1,2].

A synthesis of the two-step approach and the response surface approach to composite design is proposed in this work. The synthesis is effected by constructing a new multi-point structural approximation scheme based on an innovative use of the classical Shepard's method applied in the space of laminate stiffness. A distance measure in the stiffness space is proposed to adapt the method to composite design. The resulting global approximation is exact in value and derivative at identification points and reproduces the homogeneity properties of the considered design criteria. The global optimization strategy is presented in
Figure 1. The response surface GA optimization [3] is performed starting from a conceptual optimum defined by prior continuous optimization [4]. The efficiency of the strategy is demonstrated for several straight-fiber applications, including single-laminate design problems and patch design problems. The optimized designs for the single laminate optimization problems performed at least equally to the best previously published results for a much smaller computational effort. For patch design problems, consistent results were obtained using a fairly small number of finite element evaluations for shear buckling and compressive buckling of two-patch panels. The extension of this work for the general case of variable-stiffness structures with curvilinear fiber-paths is currently under investigation.

![Diagram of optimization strategy]

**REFERENCES**


