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# Laminate Stacking Sequence Optimization Considering Multiple Structural Cases with Two-Level Approximations and GA

**Haichao An[1], Shenyan Chen[2], Hai Huang[3]**

[1] School of Astronautics, Beihang University, Beijing, China, anhaichao@buaa.edu.cn
[2] School of Astronautics, Beihang University, Beijing, China, chenshenyan@buaa.edu.cn
[2] School of Astronautics, Beihang University, Beijing, China, hhuang@buaa.edu.cn

## Abstract

Laminated composites have widespread applications in aerospace structures, and optimization of corresponding stacking sequences is indispensable to make full use of the composite properties. Genetic algorithms (GAs) are popularly adopted to cope with the stacking sequence design, which is a combinatorial optimization problem with complicated manufacturing constraints, but they often exhibit high computational costs with many structural analyses. A genetic algorithm (GA) with a two-level approximation method [1] was previously proposed by the authors for stacking sequence optimization. It requires low computational costs, and many near optimal results can be obtained for designers.

Taking practical structures into account, it is always required to conduct optimizations under multiple structure cases. Here, the concept of multiple structure cases refers to a structural with different working modes or states to complete different tasks. When the optimization result obtained under one structural case is used for another structural case, it might be infeasible to satisfy all constraints. Thus, structural optimization by simultaneously considering all structural cases is necessary to achieve a satisfactory design. Current existing published works involving optimizations with multiple structural cases are limited, especially for laminate stacking sequence optimizations.

To solve this problem above, a new optimization model in this work was established by integrating all structural cases as constraints. The previous optimization strategy was then adopted, and at each stage after solving the first-level approximation problem, a new design point was obtained. Structural analyses were conducted at this point sequentially based on each structural case, the results of which were afterwards used for establishing the first-level approximation problem. A practical structure consisting of solar array panels which considered two structural cases, involving compacted and deployed states, was designed, and the results show that this method is effective in stacking sequence optimization when considering multiple structure cases.

## References

[1] S. Chen, Z. Lin, H. An, H. Huang, C. Kong, Stacking sequence optimization with genetic algorithm using a two-level approximation. Structural and Multidisciplinary Optimization, 48(4), 795-805, 2013.