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Topology optimisation for stress-based problems applied to laminated composite structures

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Abstract

This work presents a new approach for handling stress-based topology optimisation problems applied to laminated composite structures. Specific failure criteria are evaluated for different materials and the safety factor is calculated to normalize the failure criteria values. This safety factor is the maximum coefficient that can be multiplied to the actual loads while the failure criteria are still satisfied [1]. A multi-p-norm objective function is used to maximize the minimum safety factor value, and consequently, the maximum stress value is minimized. A volume constraint is used to prevent fully-covered domains. When using a small value of the p-norm penalisation coefficient (4 or 6), the p-norm function does not estimate well the minimum safety factor value, and thus, stress concentration can occur [2]. On the other hand, if the p-norm penalisation coefficient is large (12 or larger), the minimum safety factor value is well estimate by the p-norm function, however, it can generate a discontinuity between iterations because of the local nature of the stress. Thus, we propose the multi-p-norm objective function to prevent both problems. Furthermore, SIMP and qp-relaxation approach [3] are used in the formulation as the material model, and the MMA algorithm as the optimisation solver. We also propose to keep the p coefficient fixed and to use the continuation method to the q coefficient to improve the solutions. To illustrate the proposed approach, examples of shell structures with in-plane and out-of-plane loads are considered.

References

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