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A Novel Topology Optimization Method for Local Relative Displacement Difference Minimization

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ABSTRACT

In the topology optimization problem of mechanical structures, the optimization objectives are mainly focused on the compliance minimization, displacement minimization, stress minimization, and so on. However, in practical engineering, these kinds of optimization objectives do not meet all the requirements. Some structures, such as wind turbine blades and engine blades of aircrafts, are required to maintain a superior aerodynamic shape under external loads. This puts a higher requirement on the local deformation homogenization of the structure. Therefore, we proposed a topology optimization method for the minimization of local relative displacement differences considering stress constraints. First, we present a specific topology optimization model for the proposed method, and the P-Normal aggregation function is adopted to deal with the global stress constraint problem. Second, the sensitive equations of the objective function and the stress constraint function to the design variables are derived by the method of concomitant variables. Then, we illustrate the details of the algorithmic procedure of the proposed method. Finally, the validity of the proposed method is verified by two-dimensional and three-dimensional examples, and compared with the optimization results of compliance minimization. The results demonstrate that the proposed method has obvious superiority and potential application value in minimization of local relative displacement differences.

KEYWORDS

Topology optimization; local deformation; stress constraints; concomitant variables; local relative displacement differences

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