Optimum design of monosymmetrical non-circular hole based on EAGA with immigrant strategy

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Abstract: The bolt-holes are in many cases the most critical durability concern of turbine disk due to stress concentration. This paper proposed an 8-arcs parameterized model of non-circular hole, of which the contour could be converted for different structural load conditions, to improve fatigue performance of bolt-holes and that of the turbine disk as well. The optimization based on thermal-structural finite element analysis on a high-pressure turbine disk was conducted, indicating that optimized non-circular holes could dramatically reduce stress concentration on the holes' edge. The maximum principal stress on the holes' edge was chosen as the merit function. An elite-preserving adaptive genetic algorithm (EAGA) with modified immigrant strategy was applied in optimization and proved to be effective and efficient in relieving stress concentration, and the maximum principal stress was reduced for 14.8% after optimization. The analysis of design variables' sensitivity shows that the arcs connecting main arcs play an important role in reducing stress concentration.

Key words: Optimum design; non-circular hole; elite-preservation adaptive genetic algorithm; sensitivity analysis; immigrant strategy