OPTIMAL DESIGN OF FULL DISKS WITH RESPECT TO MIXED CREEP RUPTURE TIME

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Abstract

Structural elements working under creep conditions belong to the relatively new branches of structural optimization. Among many new possibilities of optimization criteria, which offers optimization of structures in creep conditions, the most important seems to be time to rupture. Most papers on optimal structural design are based on the brittle creep rupture theory proposed by Kachanov (small strain theory). Application of the ductile rupture theory proposed by Hoff in optimization problems are rather scare as it requires finite strain theory. For the first time it was used by Szuwalski [1], [2] and Szuwalski, Ustrzycka [4] . The first attempt of application the mixed theory to shape optimization was made by Ustrzycka and Szuwalski [3] for bars under nonuniform tension. Here, for the first time, the optimization problem with respect mixed rupture time, is solved for the complex stress state.

Application of mixed rupture theory proposed by Kachanov takes into account: geometrical changes - diminishing of transversal dimensions resulting from large strains (as in ductile rupture) and growth of microcracks (as in brittle rupture). In present paper the problem of optimal shape with respect to mixed creep rupture time for the rotating full disk is investigated. Difficulty of the problem results from two types of nonlinearities: geometrical connected with the use of the finite strain theory and physical - the material is described by the Norton's creep law, here generalized for true stresses and logarithmic strains.

The mathematical model of mixed creep rupture is described by the system of five partial differential equations in dimensionless form. The system must be integrated with respect to material coordinate (Runge – Kutta fourth order method) and to time with variable step (Euler's method). The parametric optimization with one, or two free parameters describing the initial shape of the disk is applied. The obtained results are compared with the disks with respect to ductile creep rupture time [2].

References

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