STATIONARY VIBRATIONS AND FATIGUE FAILURE OF THE ELASTIC DISKS OF VARIABLE THICKNESS

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The stress state of compressor disks of variable thickness under centrifugal and aerodynamic loads and torsional vibrations of the blades is calculated by numerical analytical method. The thickness of the elastic disk is variable along the radius. The solution is sought as Fourier series along angular coordinate and power series along the thickness. The Fourier coefficients are found numerically as solutions of the boundary value problems for systems of ordinary differential equations along the radial coordinate. The calculated stress state is used to estimate the time to the fatigue failure of the disks.

Two alternative modes of cyclic loading are studied. First mode is named LCF (low cycle fatigue) and consists of the flight cycles (take off – flight – landing). Second mode is named VHCF (very high cycle fatigue) and presents high-frequency vibrations of the disk and the blades. For the VHCF mode the known multiaxial LCF criteria are generalized using the similarity of the left and right branches of the bimodal fatigue curves. The anisotropy of fatigue properties of titanium alloy is also taken into account in these generalized criteria. As it follows from the calculations the values of times of safe operation for these two modes of cyclic loading are sufficiently close to each other. It means that alternative mechanisms of fatigue fracture should be considered simultaneously in studies of safe operation conditions. Fractographic studies of disks destroyed during operation confirm this fact. They indicate that the initial nucleation of fatigue microcracks may occur almost simultaneously in both LCF and VHCF modes.

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