19th European Conference on Fracture (ECF19) Kazan, Russia, Aug 26 - 31, 2012. // Book of Abstracts - Kazan, 2012. P. 51

Compressor disk lifetime estimations under low-cycle and very-high-cycle fatigue

Burago N.G. [1*], Nikitin I.S. [2], Shanyavski A.A. [3] and Zhuravlev A.B. [4]

[1] A. Ishlinski Institute for Problems in Mechanics of RAS, Moscow, 119526, Russia

[2] “MATI” - Russian State Technological University, Moscow, 121552, Russia

[3] *State Center* of Flight Safety of Civil Aviation, *Moscow*, *103340*, Russia

[4] A. Ishlinski Institute for Problems in Mechanics of RAS, Moscow, 119526, Russia

[*] i_nikitin@list.ru

Keywords: Multi-axial fatigue criteria, lifetime estimation, stress concentration, centrifugal loads, aerodynamic loads, disk shrouded blades and pins nonlinear contact system, FEA, flight loading cycle. very-high-cycle fatigue, low-cycle fatigue

Fatigue fracture of gas turbine engine (GTE) compressor disks is investigated. As fractured disk analysis indicates in most cases the fatigue fracture started in disk-blade contact zone.

Finite element (FE) model of real GTE disk-shrouded blades and pins is created and 3D strain-stress state is calculated under action of centrifugal, aerodynamic and nonlinear contact loads. Peak stress-strain values correspond to flight velocity 200 m/s and rotation frequency 3000 rpm. Aeroelasicity effects due to airflow and deformable structure interaction are taken into account. Lifetime estimations are found as limit number of safety flight loading cycles distribution in the structure. Several multi-axial fatigue criteria are tuned and compared between themselves and with flight exploitation data.

In addition the very-high-cycle fatigue (VHCF) due to observed high frequency axial vibrations of shroud ring is studied. It is assumed that vibration amplitude is equal to ±1mm under frequency 3000 rpm. Lifetime estimations are found also as limit safety vibration number according to VHCF criterion. Due to absence of experimentally proved VHCF criteria the known low-cycle fatigue (LCF) criteria are applied. LCF criteria are tuned by using available poor uniaxial VHCF experimental data.

In both cases fatigue fracture zones are situated and approximately coincide with those observed during flight exploitation. Integral lifetime estimation is about 20000 – 50000 flight loading cycles. It points out on possibility of alternative fatigue fracture mechanisms for compressor structure under consideration.

The research is performed under financial support of Targeted Federal Program “Research and Pedagogical Cadre for Innovative Russia" for 2009-2013 and RFBR Projects 12-08-00366-a, 12-08-01260-a.