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АНАЛИЗ ДИНАМИЧЕСКОГО ПОВЕДЕНИЯ КОНЕЧНО-ЭЛЕМЕНТНОЙ МОДЕЛИ СБОРНОЙ КОНСТРУКЦИИ РОТОРА АВИАЦИОННОГО ГАЗОТУРБИННОГО ДВИГАТЕЛЯ

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ANALYSIS OF THE DYNAMIC BEHAVIOR OF THE FINITE-ELEMENT MODEL OF THE ASSEMBLY DESIGN OF THE ROTOR OF THE AVIATION GAS TURBINE ENGINE

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Rotary systems (Figure 1) of modern gas turbine engines (GTE) are designed with high demands of reliability and durability for their dynamic behavior under operating conditions in the nominal modes. A wide range of experimental and theoretical approaches to engineering analysis is used for this. Mathematical modeling with the use of the finite element method shows high efficiency, in particular with the elasticity theory contact problem solution of the rotor details conjugation conditions modeling. However, even more difficult task is the extraordinary situations modeling under these conditions, for example, in the form of the rotor blade breakage.

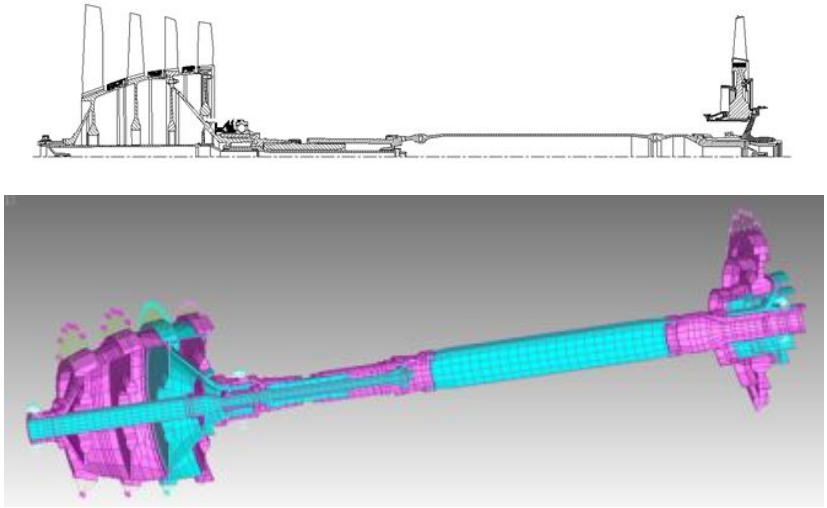

Fig. 1. The aircraft GTE low pressure rotor and its dynamic finite element model, taking into account the contact in the joints of the parts

Fig. 2 shows the program of rotation frequency change of low-pressure rotor, starting from the standard spinning mode, modeling the Simulation of the First Stage Blade Breakage at the maximum mode and leaving for the autorotation mode.

The total running time consists of four periods (figure 2): - starting from zero to the maximum speed (10920 rpm); - work at maximum speed, during which the blade breakage is simulated; - deceleration of rotation; - work in autorotation mode - 30% of the maximum speed (3276 rpm).

To simulate the very process of the blade breakage, the data obtained in the course of the full-scale experiment are used in the form of the measured values diagram of the 1st stage impeller gravity center of the low-pressure rotor (LP) acquired during the eccentricity blade breakage.

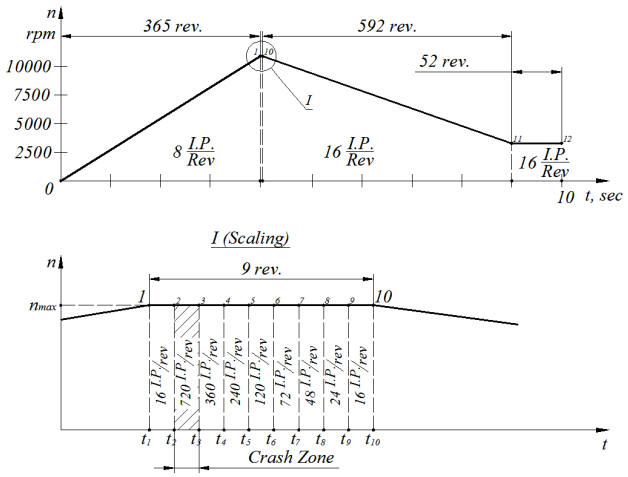

Fig. 2. Program of rotation frequency change of low-pressure rotor during the simulation of the first stage blade breakage

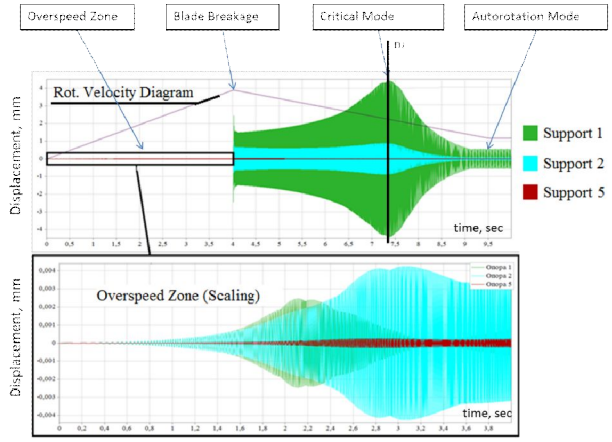

Fig. 3. Displacement of the Low-Pressure Rotor Supports due to the Blade Breakage and Deceleration to Autorotation Mode

The results of the calculation (Figure 3), in the form of the diagram during acceleration, the output to the maximum mode, the blade breakage and the transition to the autorotation mode of the rotor dynamic behavior, show a significant drop in the oscillations amplitude in the blade breakage, when switching to the autorotation mode.

Proportional to the displacement of the low-pressure rotor supports (Fig. 3), there is a change in the rotor design, for example (Fig. 4), in the critical mode (response) when switching from the maximum mode to the autorotation mode. It is with respect to this regime that the short-term strength and durability of the rotor structure and its supports should be evaluated.

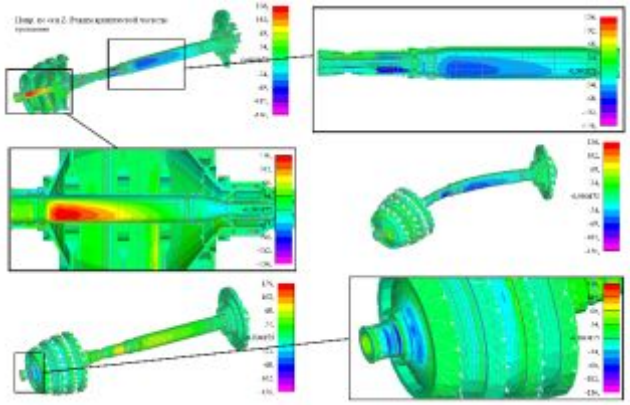

Fig. 4. Low-Pressure Rotor Shaft Bending Normal Stresses (MPa) at the Critical Mode during Deceleration to Autorotation Mode

The results of the rotor dynamic analysis during the blade breakage show the effectiveness of the experimental-theoretical approach in the study of this issue with the goal of analyzing the rotor parts strength and durability during its operation in extraordinary situations.

УДК 621. 6

ПОВЫШЕНИЕ ЭФФЕКТИВНОСТИ ГАСИТЕЛЕЙ ПУЛЬСАЦИЙ ДАВЛЕНИЯ

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IMPROVEMENT OF EFFICIENCY OF DAMPERS OF PRESSURE PULSATIONS

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In the report results of researches of dynamic characteristics of acoustic dampers of fluctuations of a liquid are resulted at the account of longitudinal distribution of parameters. It is shown that it is advisable to use multi-tier device circuits to improve performance.

Для демпфирования пульсаций давления в гидравлических системах машин часто применяют пассивные акустические гасители, схемы которых построены по принципу электрических фильтров нижних частот.