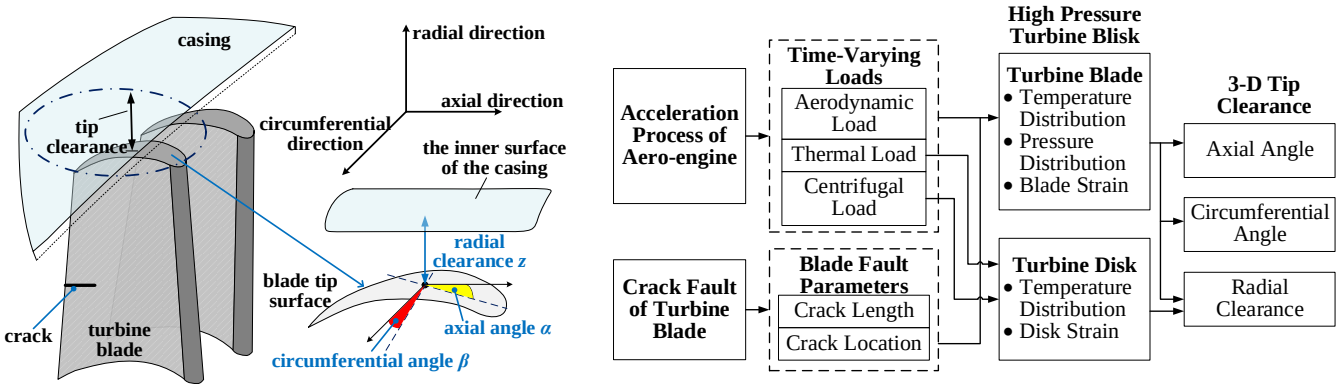
Research on the Variation Mechanism of the 3-D Tip Clearance of a Cracked Blade under Multi-parameters in the Aero-engine Acceleration Process

Yiwei Xiong[1], Xiaodong Zhang[1,2], Siying Xie[1], Hongcheng Liu[1]

[1]School of Mechanical Engineering - Xi'an Jiaotong University
[2]Key Laboratory of Education Ministry for Modern Design and Rotor-Bearing System – Xi'an Jiaotong University
No.28 Xianning West Road, 710049, Xi'an, Shaanxi, P.R. China
xiong1w@stu.xjtu.edu.cn; xdzhang@mail.xjtu.edu.cn

The turbine blade crack is the most typical fault of the aero-engine. The blade crack fault will lead to three-dimensional (3-D) spatial characteristics of the blade tip clearance, such as Fig.1 (a). Compared with the traditional vibration signal, the 3-D tip clearance contains more abundant fault information of the turbine blades, therefore, the research on the variation mechanism of the 3-D tip clearance is of great significance for the crack fault diagnosis of the turbine blades. However, previous researches only focused on the steady state condition of the aero-engine, lacking consideration of the aero-engine acceleration process, which has a significant effect on the blade crack fault. Therefore, in order to investigate the variation mechanism of the 3-D tip clearance of cracked blades in the aero-engine acceleration process, a numerical model of the high pressure turbine, including the turbine blade and disk, is established. In the acceleration process, the centrifugal load, thermal load and aerodynamic load of the aero-engine are varied with time, which are considered in this model. Besides, the cracks are added to the trailing edge of the turbine blades, and the blade cracks with different length and location are analysed. The deformation vectors of the blade tip surface are obtained through a finite element method, and then the variation of the 3-D tip clearance of the cracked blades can be calculated, such as Fig.1 (b). The results show that there are some clear distinctions in the 3-D tip clearance between normal blades and cracked blades, which can reflect the blade crack information accurately and effectively. In conclusion, the 3-D tip clearance can provide abundant fault information for the state monitoring and fault diagnosis of the aero-engine turbine blades, laying a theoretical foundation for the fault diagnosis of the turbine blade crack based on the 3-D tip clearance.



(a) The 3-D Tip Clearance of a Cracked Blade (b) Analysis of the 3-D Tip Clearance in Acceleration Process

Figure 1: The Variation Mechanism of the 3-D Tip Clearance of a Cracked Turbine Blade

Reference

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