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Vibration and Damping Analysis of the Bladed Disk with Damping Hard Coating on Blades

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Abstract: For the blisk (integrally bladed disk) with damping hard coating on blades, an analytical approach is developed to calculate its free vibration characteristics and damping effect, based on the constitutive model of complex modulus and Rayleigh–Ritz method. Firstly, by using of the Oberst beam theory, equivalent elastic modulus and loss factor of the coated blade are derived. Then energy equations of the bladed disk on basis of complex modulus are given. By employing a set of orthogonal polynomials as the admissible function, the Rayleigh-Ritz method is used to formulate the equations of motion. Solutions are obtained as complex eigenvalues, whose real parts are undamped frequencies and imaginary parts represent the damping coefficient. Further, frequency response function can be achieved, by using of proportional damping model to obtain damping matrix. An academic bladed disk made of stainless steel is taken as example to conduct numerical calculation, and compared with the experimental results by both natural frequencies and modal shapes. NiCrAlY coating is deposited on single side of the blades to investigate its effect on the natural frequencies, modal loss factors and frequency responses. At last, influence of the coating thickness on the variation of natural frequencies and damping capacity is discussed.

Keywords: Integrally bladed disk, damping hard coating, vibration analysis, complex modulus, loss factor, Rayleigh–Ritz method

1. Introduction

The integrally bladed disk (also known as blisk) has been more and more widely