INTERFACE DAMPING IN BLADE ATTACHMENT REGION

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MOHAMMED ABDUL WASAY USMANI

DEPARTMENT OF MECHANICAL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY, DELHI

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CERTIFICATE

This is to certify that the thesis entitled "INTERFACE DAMPING IN BLADE ATTACHMENT REGION" being submitted by Mr. M.A.W. Usmani to the Indian Institute of Technology, Delhi (India) for the award of the Degree of Doctor of Philosophy in Mechanical Engineering Department, is a record of bonafide research work carried out by him under our supervision and guidance. The thesis work, in our opinion, has reached the standard fulfilling the requirements for the Doctor of Philosophy Degree. The research report and the results presented in this thesis have not been submitted in part or full to any other University or Institute for the award of any degree or diploma.

J.S. Rao

Prof. J.S. Rao
Department of Mechanical Engineering
Indian Institute of Technology, Delhi.

C.V. Ramakrishnan

Prof. C.V. Ramakrishnan
Department of Applied Mechanics
Indian Institute of Technology,
Delhi.

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M.A.W. Usmani

ABSTRACT

Energy dissipation is a major blade design criterion since damping limits the blade resonant amplitudes and stresses which may develop under steady operating conditions with harmonic forcing input. Blade damping is therefore a desirable structural property which helps to reduce the possibility of blade damage from metal fatigue. A major contribution of damping in a free standing blade arises from the interface slip that take place in the blade root junction. This thesis is concerned with the estimation of damping in the blade disk junction.

The present work addresses the problem of evaluation of root damping using analytical and experimental procedures. To study the problem analytically, the finite element method has been made use of and to simulate the blade - root behaviour, the dynamic contact problem under the action of centrifugal force and a lateral load is analysed using a time marching procedure.

A general purpose computer program consisting of a main program and twenty eight other segments has been developed. The program is very efficient since only the equations corresponding to the contact nodes, loaded noded and the nodes which leave contact are set up at every iterative step within a time interval. The program is capable of handling inclined contact surfaces and the presence of clearances.

A free vibration analysis of a blade with T and straddle-T type root junction has been made to determine the lograthmic decrement at successive time steps. To estimate the true behaviour, the initial displacements have been obtained by solving static contact problem. The damping ratio has been obtained as a function of centrifugal load and tip displacements.

A test rig to determine the damping of a blade-root is designed and fabricated using thermal cooling to simulate the centrifugal load. The tests can be carried out in air as well as in vacuum. Experiments have been conducted to estimate blade damping and attempts have been made to correlate it with the theoretical investigations mentioned earlier. While the qualitative trend is found to be alright, there is considerable deviation from the theoretical prediction on account of the practical conditions in which the blade is mounted.

The thesis ends with a detailed summary of conclusions and suggestions for future research.

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