Analisi sperimentale e teorica dell'effetto degli smorzatori sottopala sullo smorzamento delle vibrazioni nelle palette di turbina.

Abstract

In the field of turbomachinery, the most common failure of the turbine blades is High Cycle Fatigue (HCF) caused by the fluctuating stresses at the blade resonance conditions. Due to the tremendous environment inside the turbine, a blade with resonance-free working range is not possible. HCF in the turbines is so malignant in nature that a very small crack invisible to the naked eye on a single blade can leads to a complete failure of the engine. Therefore, one of the prime concern of designers is to limit these stresses and overcome these kind of failures. In this regard, different friction damping devices e.g. shrouds, lacing wires, ring dampers and under-platform dampers are introduced in the system to reduce the response amplitude of the blades by dissipating their vibration energy.

In this thesis, an extensive experimental as well as numerical based research activity has been carried out to investigate the under-platform dampers. Due to the complex nature and locally introduced nonlinearities by the friction, simulation and prediction of the damper behavior is still an open problem. In all numerical modeling techniques of the under-platform dampers, information corresponds to the damper contact parameters are complementary. A novel test rig has been developed in this thesis, which is capable to directly measure the damper contact forces and relative displacement, in addition to the measurements of the blade standard FRFs. These direct measurements are then post-processed to estimate the equivalent contact parameters and for the very first time, an attempt has been made to relate the micro behavior of the damper in terms of contact parameters with the macro dynamic behavior of the damper-blade system in terms of frequency response variation. This newly proposed idea of associating the micro and macro behavior of the dampers provides a distinct and more realistic prospect of studying the under-platform dampers.

Moreover, during this activity, a dummy blade was also developed to test the semi-cylindrical dampers and verify the working potential and accuracy of this novel test rig by comparing the results obtained on a different test rig for the same damper. Finally, the measured contact forces are used as external forces in the numerical model of the blade and the final results are validated with the experimentally measured frequency response of the blade.