

EXPERIMENTAL STUDIES OF RUB CONTROL WITH AN ACTIVE AUXILIARY BEARING

Lucas Ginzinger

Institute of Applied Mechanics, Technical University Munich

Boltzmannstr. 15, 85748 Garching, GERMANY

e-mail: ginzinger@amm.mw.tum.de

Tel. +49/89/289/15199

Fax. +49/89/289/15213

Heinz Ulbrich

Institute of Applied Mechanics, Technical University Munich

Boltzmannstr. 15, 85748 Garching, GERMANY

ABSTRACT

A new approach to control a rubbing rotor by applying an active auxiliary bearing is presented. The auxiliary bearing is attached to the foundation via two unidirectional actuators. The control force is applied indirectly using the active auxiliary bearing, only in case of rubbing. A robust control system has been developed which reduces the intensity of rubbing significantly by stabilizing the rotor system and assuring an optimal rubbing state.

The model based cascade control consists of a feedback control of the actuators, the computation of the target trajectory and an activation routine which tracks the orbit of the rotor. The control system is activated shortly before the occurrence of the first impact, if a contact between rotor and the auxiliary bearing is inevitable. In the first phase, when the contact is still open, a target trajectory for the movement of the auxiliary bearing is determined, which synchronizes the auxiliary bearing with the orbit of the rotor. The synchronization is followed by a smooth transition to a contact. Thereby, the relative velocity is minimized, depending on the deflection of the rotor. In the second control phase (during contact) a target trajectory is determined, which keeps a permanent contact with low contact forces and produces a state of synchronous full annular rub. Furthermore the controller assures at all times that the rotor deflection does not exceed the initial air gap of the auxiliary bearing, to keep its general purpose in mind – the limitation of the deflection. The feedback control of the actuators is based on a feedback linearization and assures an accurate and robust motion control of the auxiliary bearing throughout the full range of possible contact forces and impacts. In the plane perpendicular to the rotor at the location of the auxiliary bearing the displacement of the rotor and the auxiliary bearing are measured. Only these signals are used for the controller.

On a test rig the performance of an active auxiliary bearing has been studied experimentally. Various experiments including the passing of a critical speed and the occurrence of a sudden arising unbalance will be presented. A parameter study of the friction coefficient shows the wide operation range of the system. By using the proposed control system the contact forces are reduced up to 90 per cent and the rotor deflection decreases significantly.

Keywords: active auxiliary bearing, rotor rubbing, feedback control