Control Strategies for Active Vibration Control via Twin Rotor Damper

Richard Bäumer and Uwe Starossek

Hamburg University of Technology, Hamburg, Germany

Contact: richard.baeumer@tuhh.de

Abstract

The twin rotor damper (TRD) is an active mass damper. It comprises a pair of eccentric masses that rotate about parallel axes. In a preferred mode of operation, the continuous rotation mode, the two masses rotate with constant angular velocity in opposite directions. The resultant of the induced centrifugal forces is a directed harmonic force that can be used for damping. In previous theoretical work, a control algorithm for the continuous rotation mode was developed. However, when the vibration amplitudes become small, this control algorithm does not lead to the desired constant motion of the rotors. The TRD can even re-excite the motion of the system instead of damping it. Various approaches can be used for preventing these undesired effects. For instance, a second identical TRD unit can be added. When the vibration amplitudes are large, both units work in unison and damp the motion. When the vibration amplitudes become small, a phasing is introduced between the two units so that the control forces of both units more and more neutralize each other. Control strategies implementing this and an alternative approach have been developed and proven experimentally.

Keywords: force, twin rotor damper, forced oscillation response, harmonic damping force, loop-shaping, observer based control, closed-loop control.

1 Introduction

The TRD is an active mass damper. The damping efficiency of the TRD has been numerically proven for pedestrian induced vibrations, wind-induced bridge vibrations and wind turbine towers [1, 2, 3].

The greatest advantage of the device is the manner the control force is created in the preferred mode of operation. In this mode of operation, the continuous rotation mode, two eccentric control masses rotate with a constant angular velocity about two parallel axes. The generated centrifugal forces are used for damping. As only small accelerations are required in this continuous rotation mode the power demand on the actuators as well as the energy consumption are extremely low. This is in contrast to conventional active mass dampers, which generate their control action by continuously accelerating and decelerating a control mass, thus requiring a large power demand and a high energy consumption [4].

2 Twin rotor damper

2.1 Layout

As indicated in Fig. 1, the TRD consists of two control masses $m_c/2$ hinged with the radius r_c to two parallel axes [4]. The angular position $\varphi(t)$ defines the motion of both rotors. In the continuous rotation mode both control masses

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