# Development of Adaptive Impact Dampers for Mitigation of Free and Harmonically Excited Vibrations

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## ABSTRACT

The contribution presents the concepts, numerical and experimental studies of two innovative types of adaptive impact dampers. The first proposed device is the Adaptive Tuned Particle Impact Damper (ATPID) [1], whose construction resembles the classical impact damper with a single moving particle. The novelty of the proposed design is application of a changeable volume container with a moveable upper wall, which is connected to the electric engine. The control of the engine operation enables changing the upper wall's position and tunes the container volume during the vibration mitigation process. Such control affects the movement of the grain and velocity of its collisions with container walls, which are crucial for the effectiveness of the vibration damping.

To extend the operation capabilities, the authors also propose the Adaptive Pneumatic Impact Damper (APID) which consists of a constant-volume container with two pressure chambers separated by a piston equipped with a controllable valve [2]. The effective vibration mitigation mechanism results from the movement of the piston inside the container and the forces generated on its bases due to the occurrence of pneumatic forces or direct piston impacts. In both cases, the magnitudes and duration of force impulses can be effectively modified by the use of controllable valve. Consequently, the system enables adaptation to actual dynamic loading and increase of vibration damping effectiveness.

The presented analysis concerns application of the ATPID and APID for damping of free and harmonically excited vibrations of cantilever beam. The research focuses on mathematical modelling of physical phenomena occurring in the both types of dampers and development of the control strategies for efficient vibration mitigation. The obtained numerical and experimental results prove large adaptation capabilities and very high efficiency of the proposed devices in vibration damping.

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