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Optimal design of a double coil magnetorheological fluid damper with various piston profiles

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Abstract

A magnetorheological (MR) damper is one of the most advanced devices used in a semi-active control system to mitigate unwanted vibration because the damping force can be controlled by changing the viscosity of the internal magnetorheological fluids (MRF). This study proposes a typical double coil MR damper where the damping force and dynamic range were derived from a quasi-static model based on the Bingham model of MR fluid. A finite element model was built to study the performance of this double coil MR damper by investigating seven different piston configurations, including the numbers and shapes of their chamfered ends. The objective function of an optimisation problem was proposed and then an optimisation procedure was constructed using the ANSYS parametric design language (APDL) to obtain the optimal value of a double coil MR damper. Furthermore, an experimental analysis was also carried out. These results were then compared with the optimised MR damper's simulation results, which clearly validated the simulated results. The relevant results of this analysis can easily be extended to other MR dampers.

Keywords: MRF, MR damper, Double coil, Finite element analysis, Optimal design.