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Optimal dynamic vibration absorber for friction-induced vibration mitigation

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Abstract: Friction-induced vibrations appear in diverse fields of science, ranging from squeal of braking vehicles and earthquakes, to musical instruments such as violins. In engineering systems they are generally undesired and designers try to mitigate them whenever possible. In this work, we aim at suppressing friction-induced vibrations of a host mechanical system by adopting a passive dynamic vibration absorber. The host structure consists of a single degree-of-freedom oscillator in contact with a moving belt (usually referred to as mass-on-belt), while the vibration absorber is attached to the mass through a spring and a damper. Two different aspects are considered for the optimization of the absorber. First, the stable region of the trivial solution of the system, with respect to the belt velocity, is maximized. A fully analytical approach enables us to identify the optimal absorber parameters for obtaining the largest possible stable region. These are expressed in practical compact formulas. Then, adopting a mixed analytical-numerical approach, the nonlinear parameters of the absorber are tuned in order to narrow the so-called bistable region of the system and to reduced vibration amplitude when full suppression is not reachable.

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