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EXPERIMENTAL VERIFICATION OF NONLINEAR DAMPING INDUCED BY SLIPPING INTERFACES

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Abstract: Optimization of fatigue endurance is a common practice in vibratory system design, but it is always hard to meet the expected requirements due to the difficulty in damping estimation. Damping is essentially an external representation of energy dissipation, which takes mainly two forms: material damping and friction damping. In industrial assembled structures, where the majority of components are connected by rivet or bolt, the friction damping is normally 10-100 times higher than material damping. Therefore a reliable estimation of friction damping in the first place, as well as its optimization in the second place, is the basis for a correct fatigue endurance design. The current study can be divided into two parts: the first part presents an analytical model based on a clamped sandwich plate. The evolution of damping coefficient versus modal amplitude is chosen as the analyzed parameter. The frictional damping, in this case, is shown to be a function of modal amplitude and it can be influenced by contact properties like the clamping pressure, the coefficient of friction and the contact quality. The influence of geometric characteristics is then evaluated by finite element method in Abaqus. The numerical results point out that damping capacity is sensitive to macroscopic geometry such as curvature of the contact surface and the thickness ratio between the two plates. The boundary condition is also proven to be an influential factor for damping formation. The above studies provide the possibility for damping optimization in industrial application. The second part deals with the experimental verification of the analytical damping model. An experimental set-up was designed and the damping can be evaluated by a differential system with the help of an equivalent dynamic hysteresis model. The damping evolution is traced in terms of clamping pressure and vibration amplitude. The experiment results show the same damping evolution as the analytical model. Damping induced by the frictional interface is thus proven to be nonlinear and its optimization is verified to be feasible.