University of Stuttgart
Germany

Announcement – Master's Thesis

Numerical Modeling and Validation of Nonlinear Energy Sinks (NES) for Passive Vibration Mitigation Considering Plastic Material Behavior

Motivation:

Nonlinear Energy Sinks (NES) are innovative concepts for passive vibration mitigation in mechanical structures that are effective over a broad frequency range. A particularly simple form of NES is the Impact Energy Scatterer or Impact Damper. This type of damper consists of a small, typically spherical auxiliary mass that collides with a carrier structure within a cavity. The effectiveness of these dampers is based on the redistribution of vibration energy into higher frequency modes through the impacts, allowing the energy to be quickly dissipated.

However, the impacts of the damper cause inelastic deformations in the initially flat housing wall, resulting in a crater. The surface topography is known to have a decisive influence on the effective contact stiffness, which affects the effectiveness of the NES. Therefore, this project aims to develop and validate a method for predicting inelastic crater formation.

Research Question:

How can the plastic deformation and the resulting change in effective contact stiffness at the contact point between the primary structure and the sphere in the NES be predicted?

Procedure:

The master's thesis involves developing a finite element model (FEM) of the host structure and the NES using a numerical FEM program such as ANSYS or Abaqus. The main steps are model implementation, where material properties including elastic and plastic behavior models are defined, and contact models are applied. Subsequently, simulations of surface deformation due to the impacts of the sphere are conducted, and the effective contact stiffness is determined. The analysis and validation include the evaluation of model quality based on deformation and effective contact stiffness, as well as the comparison of results with experimental data. Finally, various plastic material models and coupled thermo-mechanical effects are examined to further expand the method.

Requirements: Ideally, you have experience in mechanical engineering, civil engineering, computational engineering, physics, or a related discipline. You should have knowledge of finite element analysis and experience with FEM software such as ANSYS or Abaqus. Basic knowledge of dynamic analysis, coupled problems, and material modeling within the framework of the finite element method is advantageous. Additionally, good analytical and organizational skills, as well as the ability to work independently, are of great importance.

The master's thesis will be supervised in collaboration with the "Institute of Structural Mechanics and Dynamics in Aerospace Engineering (ISD)" and the "Institute of Aircraft Propulsion Systems (ILA)."

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