8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

CONTROLLED FRICTION DAMPING BY SEMI-ACTIVE JOINTS

Lothar Gaul[1]

[1] Institute of Applied and Experimental Mechanics, Universität Stuttgart
Pfaffenwaldring 9, 70550 Stuttgart, Germany
gaul@iam.uni-stuttgart.de, www.iam.uni-stuttgart.de

Key Words: *Semi-Active Joints, LuGre-Friction Model, Experimental Parameter Identification.*

ABSTRACT

Lightweight structures typically have low inherent structural damping. Effective vibration suppression is required, for example, in certain applications involving precision positioning. The present approach is based on friction damping in semi-active joints which allow relative sliding between the connected parts. The energy dissipation due to interfacial slip in the friction joints can be controlled by varying the normal pressure in the contact area using piezo-stack actuators. A numerical model of the adaptive structure is presented, including the nonlinear dynamics of the friction joints. The finite element model of the truss structure is updated by using data from Experimental Modal Analysis. The parameters of the Lu Gre-friction model are identified from measurements on an isolated friction joint. To obtain a low order model a reduction method is proposed, which is a combination of balanced reduction and matching moments method. A numerical example illustrates the approximation quality of the reduced model. The paper incorporates the optimal placement of semi-active joints for vibration suppression. The proposed method uses optimality criteria for actuator and sensor locations based on eigenvalues of the controllability and observability gramians. Optimal sensor/actuator placement is stated as a nonlinear multicriteria optimization problem with discrete variables and is solved by a stochastic search algorithm. At optimal locations, conventional rigid connections of a large truss structure are replaced by semi-active friction joints.

Two different concepts for the control of the normal forces in the friction interfaces are implemented. In the first approach, each semi-active joint has its own local feedback controller, whereas the second concept uses a global, clipped-optimal controller. Simulation results for a 10-bay truss structure show the potential of the proposed semi-active concept.