Paper ID: 15117
oral

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures - Dynamics and Microdynamics (3)

Author: Dr. Yohsuke Nambu
Osaka Prefecture University, Japan, nambu@aero.osakafu-u.ac.jp

Mr. Shota Yamamoto
Osaka Prefecture University, Japan, 10_yamamoto_shota@aero.osakafu-u.ac.jp
Prof.Dr. Masakatsu CHIBA
Osaka Prefecture University, Japan, chiba@aero.osakafu-u.ac.jp

NEW OPTIMIZATION APPROACH FOR MULTIPLE DYNAMIC VIBRATION ABSORBERS

Abstract

This paper deals with H_∞ optimization method for multiple dynamic vibration absorbers (DVAs). DVA is a most famous device to suppress vibration of a structure. Simplest system of DVA is for a system of one degree of freedom and consists of a mass, a spring, and a dash-pot. Though this conventional DVA realizes very efficient passive vibration control, its performance is not robust. When dynamic properties such as the natural frequency and the damping ratio of the main system change, the performance of DVA becomes far lower. To improve the robustness of DVA, multiple DVAs have received attention. Multiple DVAs consist of several DVAs that have lower damping ratios of the optimal value of single DVA and uneven natural frequencies around the optimal natural frequency of single DVA. Then the robustness becomes higher under the same total masses of DVAs. Optimization of multiple DVAs is primal issue of recent researches of DVA. Most researches deal with natural frequencies and damping ratios of DVAs as design parameters, however mass distribution and attached placements are very important in case of vibration control of continuous systems. Therefore this research proposes the new H_∞ optimization method to optimize natural frequencies, damping ratios, mass distribution, and attached placements of multiple DVAs. It is difficult to solve this optimization problem by a conventional optimization algorism, because the objective function is discontinuous with respect to these design parameters, where the objective function is the H_∞ norm of the transfer function of system with multiple DVAs. To overcome this problem, our method introduces a new norm progression that converges to the H_∞ norm of the transfer function. Objective function using this norm has well convergence property in an extended Lagrange multiplier method. This new approach enables to calculate optimal design parameters of multiple DVAs for vibration controls of continuous systems. This paper also deals with optimization of electrical DVAs, namely shunt circuits of inductors and resisters, for a cantilever attached with piezoelectric ceramics as an example of application. Then the numerical simulation and the experiment of this cantilever showed that multiple electrical DVAs were able to suppress the vibration of the beam more robustly and effectively. This result verifies that our new approach is useful.