MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Poster Session (P)

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OPTIMAL WIRING CONFIGURATION OF MULTIPLE PIEZOELECTRIC TRANSDUCERS FOR SSDI VIBRATION SUPPRESSION

Abstract

In this paper, the performance of semi-active vibration suppression by using piezoelectric transducers, called as a LR-switching or a synchronized switch damping on inductor (SSDI), is investigated and optimized from a viewpoint of practical application to satellite structures. This vibration suppression method converts structural vibration energy into electrical energy as a charge in the capacitance of the piezoelectric transducers. Then the polarity of this charge is inversed according to the phase of structural vibration by a switched inductive shunt circuit, so that the piezoelectric transducer generates the right polarity of force to suppress the structural vibration effectively. Previously, the authors have experimentally demonstrated that this method can reduce the vibration amplitude of 140kg satellite by 50 percent by using 80g piezoelectric transducers [IAC-10-C2.9.1]. In that demonstration, it revealed that multiple piezoelectric transducers needed to be attached to the actual artificial satellite structure because of the limitation of space where the piezoelectric transducers can be attached. It was also shown that the performance in suppressing the vibration heavily depends on the parallel/series configuration of electrical wiring for these multiple transducers. In this paper, we first show that the performance in vibration suppression by using a given amount of piezoelectric material is dominated by a parameter called as inverse ratio. Next, a mathematical model of the characteristics of piezoelectric transducers is established as a function of frequency based on measured data. Subsequently, it is experimentally verified that this model can properly predict the value of inverse ratio. And finally, the optimal parallel/series ratio of wiring of the transducers is analytically derived based on this verified mathematical model.