7th ECCOMAS Thematic Conference on Smart Structures and Materials
SMART 2015
A.L. Araújo, C.A. Mota Soares, et al. (Editors)

Abstract ID-097

MECHANICAL ENERGY MANAGEMENT FOR SEMI-ACTIVE DAMPING OF IMPACT BORNE VIBRATIONS.

Arkadiusz Mróz, Jan Holnicki-Szulc

Institute of Fundamental Technological Research Polish Academy of Sciences, Poland
amroz@ippt.pan.pl ; holnicki@ippt.pan.pl

Keywords: Semi-Active Control, Free Vibration Damping

Summary: In this paper an attempt is made to present – both as results of simulations and as results of experiment – methods which utilize structural energy accumulated after impact in order to mitigate resulting vibrations. General aim for this type of methods is to use devices installed in the structure to introduce a control force which opposes the oscillatory movement initiated at impact, without a considerable additional energy sources. The control force is applied using as energy source either strain or kinetic energy of the vibrating structure itself, thus the methods are considered semi-active.

For strain energy management it is assumed that there is a certain device or devices installed in the structure capable of imposing kinematic constraints on some degrees of freedom of the system. Given such devices are in place, the strain accumulated in the structure could locally be released for a short period of time, converting part of the strain energy to the kinetic energy of local, higher frequency vibrations. This strategy, so called, Prestress Accumulation-Release (PAR), has been shown numerically to have a very high efficiency in vibration mitigation.

In the first part of this paper an experimental stand is described which demonstrates PAR strategy on a frame test structure with semi-active nodes based on piezoelectric actuators. Characteristics of the semi-active node are shown and results in terms of vibration amplitude mitigation are presented with impact and initial displacement used as the excitation.

For kinetic energy management it is assumed that there is a certain device or devices installed in the structure capable of storing a part of the system energy in the form of rotating element (known as inerter). Stored kinetic energy is then utilized to introduce the control force that opposes the oscillatory movement of the system. Again no considerable external energy sources are used therefore the method is also semi-active. In the second part of the paper the efficiency of this approach is demonstrated numerically on an example structure with semi-active nodes.