Załącznik 2 do Wniosku

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PhD Thesis synopsis

„Noise and vibration reduction of a device enclosed in a thin-walled casing with the use of structural interactions"

Enhancement of noise level, as a result of vibration of the structures, has been observed along with the technological progress. Researchers put efforts to reduce exposure to noise and vibration in the environment, and three types of methods may be distinguished: active, semi-active, and passive ones. Also, different types of casings enclosing noise-generating devices may be employed. Many applications of the noise and vibration control methods are examined in an anechoic environment. Thus, a concept of a device casing under active structural acoustic control is further developed, where the casing is placed at a wall or in a corner, to provide intentional interactions between the casing and the reflective surfaces. The casings are frequently built of the single plates, and the field of research on the double-panel structures has not been thoroughly explored yet. Hence, the dissertation introduces also a novel modification of a double-panel structure with solenoids employed as the couplings between the panels.

In the first part of the research, the aim of the experiments was to analyze primary and secondary paths of the lightweight device casing placed at a wall, and to analyze active control performance of the casing placed in a corner. The experiment for the casing placed at a wall provided relevant information about the beneficial distances between the casing and the wall, in terms of magnitude decrease at the specific frequencies. Increase or decrease of the amplitude responses of primary and secondary paths was similar, hence the balance between them was sustained, so they did not have a negative impact on active control performance. Results for the casing placed in a corner showed that the appropriate error microphones' arrangement and a corner-casing distance may lead to global noise reduction level enhancement in a wider frequency range, in comparison to the results obtained inside the acoustic foam-covered laboratory. The error microphones placed in a narrow space between the casing and the corner may negatively impact the active control performance, and for the specific casing-corner distance values it was beneficial to turn them off. The influence of actuators (located on the panels facing the corner) on the active control system performance was examined. The important role of vibrational couplings between the casing panels was confirmed. The actuators excited the whole casing efficiently and it was equally beneficial to locate them at the panels near to the corner walls as at the opposite side. The research outcome provides a possibility to simplify the control system in a particular configuration by reducing the number of sensors and actuators.

In the second part of the research, panels of the double-panel structure interacted with each other by means of electromagnetic actuators called solenoids. The influence of such setup on vibroacoustic properties of the structure was examined. Five couplings were mounted between the panels, as preliminary setup with one solenoid did not provide satisfactory results. The first experiment was performed with the vibration sensors, and two phenomena were observed. The vibration energy was transferred to different areas of the radiating panel if, for the specific coupling, duty cycle of a modulated voltage signal increased. There was a stronger transfer of vibrations from the incident panel to the radiating one, if all five couplings were activated with a specific duty cycle value of the voltage signal. The central solenoid's activation had the most significant impact on the vibration reduction at the radiating panel. However, the influence of other couplings on vibration reduction at the radiating panel was not without significance, even if they acted as the mass loadings only in a particular configuration. The analysis of radiating panel's vibration in frequency domain indicated that proposed locations of the couplings may provide vibration reduction in a wide frequency band, but to ensure that the best effect is achieved, an optimization algorithm should be developed. Also, an estimate of Sound Transmission Loss was determined. The promising effect of coupling the structure with electromagnetic elements was observed in a wide frequency band, where STL was enhanced. Thus, the modified structure provides satisfactory results in terms of both vibration reduction and noise insulation. It has been confirmed that employment of the double-panel structures for noise and vibration reduction, with the use of additional couplings, is reasonable.