Streszczenie rozprawy w języku angielskim

The subject of the thesis was the application of microelectromechanical systems (MEMS) for the recording and analysis of the dynamic response of mechanical structures subjected to the impact of an explosion shock wave. The aim of the work was to develop and verify a measurement system capable of recording rapidly changing dynamic signals, and to determine the influence of the dynamic properties of the MEMS accelerometer used on the measurement results obtained.

As part of the study, a proprietary data acquisition system was developed to work in conjunction with the MEMS accelerometer, enabling the recording of signals at a sampling rate of 100 kHz. Laboratory and field tests were carried out, the results of which confirmed the possibility of recording short-duration acceleration pulses generated during shock wave impact and the use of the obtained signals to analyse the dynamic response of the structures under investigation.

A key element of the research was the development of a numerical model of impulse loading within the LS-DYNA environment. Analyses were carried out using models describing the shock wave, including the Friedlander model and the CONWEP method. A comparison of the calculation results with the experimental findings showed good agreement, confirming the validity of the modelling assumptions.

The study also involved a detailed characterisation of the actual structure of the MEMS accelerometer under investigation. The use of computed tomography, optical interferometry, SEM electron microscopy, EDS analysis and vibrometric measurements enabled the determination of its geometric, material and dynamic parameters. On this basis, mechanical, electrical and electromechanical models of the sensor were developed and subsequently verified experimentally. The agreement between the modelling results and the measurements confirmed the model's suitability for describing the sensor's response to impulse excitations.

The research carried out demonstrated that the dynamic properties of the MEMS accelerometer have a significant influence on the shape and interpretation of the recorded signals. This means that the use of this type of sensor for the analysis of impulse loads requires consideration of their dynamic characteristics and the influence of the sensor on the resulting measurement response.

The results obtained confirmed the feasibility of using MEMS accelerometers to record and analyse the dynamic response of mechanical structures subjected to an explosion shock wave, provided that the sensor's dynamic properties, as described by a verified electromechanical model, are taken into account. The solutions developed may form the basis for the further development of compact measurement systems designed for the diagnostics of structures subjected to impulse loads.