Summary

The subject of this dissertation is the analysis of the influence of damping on the dynamic stability of mechanical systems using the example of a truck crane boom change system.

The work has been divided into chapters covering a review of the current state of knowledge, the purpose and scope of the work and a description of the mathematical methods used in the work. The research part, in which the purpose and scope of the work are analyzed, consists of an analysis of the influence of damping on the dynamic stability of selected mechanical systems such as the Bernoulli-Euler beam in the third chapter and the truck crane boom change system in the fourth chapter. The last chapter presents conclusions and final remarks. Additionally, the dissertation contains summaries in Polish and English, a list of important symbols and lists of literature, figures and tables. The matrix elements used in the calculations are included as an appendix.

In the chapter on research methodology, the Bernoulli-Euler beam was analyzed as an example system. Using Hamilton's variational principle, after substituting the appropriate variations of potential and kinetic energy, the equation of motion and boundary conditions of the system were determined. The condition of orthogonality of eigenfunctions was determined, after which the equation of motion was transformed into the Mathieu equation, whose coefficients in correlation with the Strutt card allow determining the dynamic stability of the system. As an example, tests were carried out on the influence of the beam material on its dynamic stability. The next stage was to investigate the influence of structural damping, internal damping and external damping on the dynamic stability of the Bernoulli-Euler beam. The range of unstable solutions for the undamped beam was initially determined. The introduction of structural damping in the beam supports increased the stability of the system without eliminating the risk of parametric resonance. Internal damping did not cause significant changes in stability in relation to the undamped system. On the other hand, the introduction

of external damping allowed obtaining a stable solution in the entire analyzed area of the Strutt card.

In the fourth chapter, an analysis of the influence of damping on the dynamic stability of a real system, which was the system for changing the reach of the DST0285 truck crane, was carried out. The presented system consisting of a telescopic boom and a hydraulic actuator was modeled using Bernoulli–Euler beams and selected discrete elements. First, the boundary value problem was formulated and solved using Hamilton's variational principle, which allowed for determining the equations of motion. Geometric boundary conditions and continuity conditions were determined and based on them, the natural boundary conditions of the analyzed system were obtained. The orthogonality condition was determined and the equation of motion was transformed into the form of the damped Mathieu equation. The geometric and physical parameters adopted for the analysis of the tested model were determined. The next stage of the research was the analysis of the influence of geometry and load on the natural frequencies of the undamped system and the examination of the influence of damping on the eigenvalues of the system. An analysis of the occurrence of the parametric resonance phenomenon was carried out for selected cases of the system geometry depending on the boom inclination angle, the length of the rigging and the assumed load. The influence of the considered types of damping on the dynamic stability of the truck crane boom change system was also examined.

The fifth chapter presents a summary of the obtained results and proposes directions for further possible research.