Summary

Analysis of the ability to limit torsional vibrations in the motorcycle's steering system

The dynamics of a motorcycle is a complex issue and can lead to extremely dangerous situations. This applies not only to the rider himself, but indirectly also to other road users. The possibility of improving motorcycles in terms of their construction is sometimes insufficient, as shown by examples of even the latest motorcycles, in which vibrations occur. In many cases, this problem can be solved by introducing additional damping in the steering system, but sometimes it may work unfavorably (weave, maneuvering at low speeds).

In connection with the above, a thesis has been put forward that it is possible to improve the dynamic properties of the motorcycle through the appropriate selection of construction parameters (angular suspension, appropriate tires, etc.) and the introduction of an additional active damping system (with torsional vibration damper) incorporated in the steering.

The purpose of the work is to develop a method for the selection of geometric parameters of the steering system construction and methods for the control of the active torsional vibration damper.

The first chapter reviews literature in the field of motorcycle construction, vibrations affecting its structure and discusses the most important concepts related to the dynamics of a motorcycle. On the basis of statistics of road accidents, the risk of motorcyclists in road traffic has been assessed. A deep recognition of vibrations and disturbances in the motorcycle's movement allowed for the compilation of the most important of them in the form of a table and the separation of those that are related to the steering system. The negative impact of vibrations on human is also commented.

The second chapter contains a detailed description of the mathematical model of the motorcycle steering system, on the basis of which the analysis of the impact of construction parameters on the frequency of wobble oscillations and system natural vibrations was carried out. Different models of cooperation between the wheel and the road have also been discussed. In addition, a method was presented that allows the separation of individual vibration frequencies to facilitate the analysis and reading of the values describing them on the basis of graphs and assessed the effect of construction parameters on the vibrations of the steering system.

The third chapter discusses the test stands with the tools used to obtain the necessary measurement results and their analysis, and these have enabled the verification of the mathematical model of the steering system. The methodology for determining the directional stiffness coefficients of the tires, the moment of inertia of the wheel and the set of parameters used in the simulation model are presented.

The fourth chapter presents the synthesis method of the LQ controller based on the transfer function steering model. The results of the torsional vibration damper test were also presented, the damping characteristics of which are included in the control system. The regulator's operation was evaluated by means of computer simulation by comparing the behavior of the system without an additional damping system with the system containing the developed torsional vibration damper regulator.

Conducted research and analysis allowed to formulate conclusions confirming the thesis put in the thesis, which is the content of the fifth chapter.