SUMMARY

Summary of the doctoral dissertation:

" SYSTEMS FOR ASSESSING THE DYNAMIC STATE OF ROLLING BEARINGS BY DETERMINING THE LEVEL OF VIBRATIONS GENERATED BY THE BEARINGS"

This dissertation included a comprehensive evaluation of the newly designed MDL-54 measurement system, developed by FŁT Kraśnik S.A., dedicated to the assessment of the dynamic state of rolling element bearings. The innovation of this system lies in its ability to accurately measure bearing vibrations, despite the lack of benchmarks in the form of standard bearings and dedicated comparison systems. The aim of the study was to analyse the available theoretical and experimental data, to evaluate the measurement systems used to measure the dynamic states of rolling element bearings; to analyse the parameters used to measure the vibration and noise of rolling element bearings; to evaluate the built measurement system for the needs of the bearing industry on the basis of experimental research using mathematical statistics; to determine the usability and metrological properties of the newly built measurement station and to compare the MDL-54 system with other existing measurement systems, including MGG-11 (FAG Germany), GPW-8 (used at FŁT Kraśnik) and STPPD (Kielce University of Technology).

The dissertation begins with a review of the literature on the measurement of rolling bearing vibration, with particular emphasis on its role in mechanical engineering. Current measurement methods are presented, emphasising the importance of accurate vibration measurements as a factor affecting the quality and reliability of mechanical products. The basic principles of measurement and methods of evaluating the recorded vibration signal were also discussed, providing a background for further comparative analysis of measurement systems.

Central to the dissertation was the confirmation of the research hypothesis, which was that the MDL-54 system built, considering its metrological properties, has both theoretical and practical rationale for industrial application. The hypothesis assumed that the implementation of the MDL-54 system in an industrial setting could significantly contribute to improving the quality of manufactured bearings through more accurate monitoring of their dynamic state.

Comparative studies were carried out with four measurement systems: MDL-54, MGG-11, GPW-8 and STPPD. Each system was subjected to identical measurement procedures, covering three frequency ranges: low (LB), medium (MB) and high (HB). The χ^2 test (chi-square), kurtosis analysis and skewness of the results confirmed that the distributions of the results for all systems did not deviate from a normal distribution. This ensured the reliability and comparability of the data obtained, which was crucial for further analysis.

Several statistical analyses were carried out, such as calculations of the arithmetic mean, the interval, the standard deviation, as well as tests of comparison of means and variances. These analyses were necessary to assess the accuracy and precision of each system. Based on the results obtained, an assessment of the errors of the measurement systems was carried out, including correctness, fidelity and accuracy errors, which made it possible to determine the accuracy class of each system.

Particular attention was paid to determining the average relative measurement error, which enabled the estimation of the measurement accuracy (DP) of each system. These values were crucial to confirm the suitability of the systems for industrial applications, where high precision vibration measurements are essential. In the final phase of the study, all systems were subjected to repeatability tests, which allowed their long-term stability and reliability to be assessed.

The test results clearly confirmed the initial research hypothesis. The MDL-54 system, developed by FŁT Kraśnik, demonstrated high accuracy and precision of measurements in all analysed frequency ranges. As a result, it can be effectively applied in production conditions, contributing to improving the quality of manufactured rolling bearings. Analysis of the results confirmed that the MDL-54 system meets all metrological requirements, making it a suitable tool for monitoring the dynamic condition of bearings in industry.

Furthermore, the study showed that the MDL-54 system outperformed the other measurement systems analysed, especially in terms of measurement accuracy (DP) and stability of results. These results suggest that the newly designed system could become the standard for measuring rolling bearing vibration, especially in high-precision applications.

Ultimately, the implementation of the MDL-54 system in production processes at FŁT Kraśnik may lead to significant improvements in monitoring bearing quality, which in turn may translate into higher reliability and durability of mechanical products. The dissertation provides a solid basis for further research and development work on improving the MDL-54 system and its adaptation to a wider range of industrial applications.