Abstract

The doctoral dissertation focuses on the development and implementation of a new method for acquiring rock mass parameters in coal mines, using existing seism acoustic equipment and a newly designed intrinsically safe pneumatic seismic vibrator WZB-2. The aim of the work was to enable quasi-continuous monitoring of seismic wave propagation velocities in front of the mining face, which is crucial for assessing rock burst hazards. The use of channel wave dispersion analysis to determine their velocities, instead of the traditional method based on the first arrival of the seismic wave front, will enable high-resolution monitoring of propagation velocity changes.

In the first part of the work, the characteristics of the seismic wave field in the coal seam were presented, analyzing the types of seismic waves, their dynamic and kinematic parameters, including velocity, attenuation, and dispersion. Subsequently, using 3D numerical modeling with the finite difference method, the propagation of seismic waves in a three-layer coal seam model was investigated, which allowed for the development of a methodology for determining channel wave velocities.

The next stage involved the design, manufacture, and certification of the intrinsically safe vibrator WZB-2, adapted to work in the harsh conditions of underground coal mining. Laboratory and field tests of the vibrator were conducted, including at the KGHM O/ZG "RUDNA", KWK Mysłowice-Wesoła, and KWK ROW Ruch Rydułtowy research sites, analyzing its suitability for seismic tomography and determining seismic wave velocities.

The work also reviewed and analyzed the resolution of geophysical equipment used in Polish coal mining, assessing the capabilities of existing seismic acoustic systems. Based on the conducted field tests and data analysis, the possibility of high-resolution monitoring of seismic wave velocity changes using the WZB-2 vibrator was demonstrated, which can significantly improve the identification of subtle velocity changes indicating a changing stress field within the face.

The results of the work can contribute to increasing the safety of mining crews and reducing the occurrence of high-energy tremors. The proposed solutions align with the priority directions of scientific research and development, contributing to the development of innovative technologies in Polish mining.