

Abstract

The powered support is responsible for safety in the mining longwall. It protects people working there and other machines against falling roof rocks and coal billets falling off the face of the wall. The hydraulic system of the powered support plays an important role in the implementation of these tasks. Currently, this system performs two functions. The first one is the control of the powered roof support, and the second one is protection against unfavorable overloads resulting from the pressure of the roof rock layers. This thesis proposes a third function for the hydraulic system - charging the pressure in the space under the piston of the prop. The introduction of the charging function is intended to stabilize the load-carrying capacity force of the powered support, and thus ensure that the sections obtain the required initial load capacity and maintain working load capacity.

Load-carrying capacity is the force with which the section of the powered support acts on the roof of the excavation. The load-carrying capacity value obtained by the sections depends on many factors, including the pressure in the supply line and the technical condition of the props. This results in significant differences in the load-carrying capacity of subsequent sections in the longwall. A common problem is the operation of the section with load-carrying capacity force below the required value. When the value of the initial load-carrying capacity of a section is too low, negative phenomena occur in the seam roof, which may result in rainfall and collapse of melting rocks. This translates directly into a safety hazard in the longwall and difficulties in operation and implementation of the assumed production plans. The problem is important, both from the point of view of safety and economic results of the mine, so its solution became the aim of this PhD dissertation.

The work began with an analysis of the rock burst hazard in Polish hard coal mines. This hazard has a significant impact on the operation of powered support. Due to its growing scale, it is important to adapt the powered roof support to changing conditions. A survey was also conducted among employees of Polska Grupa Górnictwa S.A. employed in the mining longwall. The aim of the research was to check the needs of respondents in the development of powered support. The analysis of the research results showed that miners are open to new solutions and express the need to optimize currently used sections, including introducing changes aimed at maintaining the load-carrying capacity force.

The literature review shows that attempts have already been made to develop devices that were to ensure the required load-carrying capacity of the powered roof support. All these devices were designed as additional elements in the hydraulic system of the powered support. Despite operational tests, none of these devices were used in industry, and the problem of providing load-carrying capacity remained unsolved. The exception is the powered roof support with electro-hydraulic control, which can cooperate with an active pressure maintenance system. Nevertheless, in Polska Grupa Górnictwa S.A. adjacent control is most often used. Therefore, to ensure the expansion of the sections to the required initial load-carrying capacity and maintaining working load-carrying capacity, it was proposed to introduce a pressure charging function into the hydraulic system of the powered support. The solution assumes that the charging is to be carried out by the valve block, so as not to

introduce additional elements into the hydraulic system. Compared to existing designs of charging devices, this is an innovative approach.

The implementation of the adopted concept began with simulation research. In the first stage, the process of expanding the hydraulic stand was modeled, which enabled the observation of changes occurring during this operation. Then, based on empirical research, the pressure charging function was modeled. Both developed models were verified with the results of bench tests. The obtained compliance of the results allowed for conducting simulation tests on these models. Thanks to this, it was possible to determine the operating characteristics of the future prototype.

Based on the simulations performed, a prototype of the block with a pressure charging function was developed. According to the adopted assumptions, the prototype block was to perform three functions: provide expansion of the powered roof support's section to the required initial load-carrying capacity, supplement possible pressure losses under the prop piston - to maintain working load-carrying capacity and minimize the effects of possible internal leakage. In order to check the correct operation of the prototype, it was subjected to bench tests. As the tests showed, the proposed solution allowed the prop to expand to the maximum pressure value in the supply line and maintaining this value. All recorded pressure drops in the space under the piston of the prop were supplemented by the prototype system. This allowed us to move on to the next stage - research in real conditions.

The prototype was installed on a prop of a section of a powered support working in a mining longwall. The prototype replaced the standard valve block. For testing purposes, a prop with internal leakage was selected. The analysis of the measurements obtained in the longwall confirmed that the proposed pressure charging function allows the expansion of the powered roof support's section to the required initial load-carrying capacity, maintaining the working load-carrying capacity and minimizing the effects of internal leakage. Thus, the thesis of this PhD dissertation has been proven. Additionally, operational tests were carried out in which the operation of the powered roof support was compared using a standard valve block and the proposed prototype with a charging function. As research has shown, the proposed solution ensures stabilization of the load-carrying capacity force of the powered roof support, which was the aim of the dissertation.

Keywords: powered roof support, hydraulic prop, hydraulic system, simulations, bench tests, research under real conditions

Borska