http://dx.doi.org/10.7494/miag.2019.4.540.55

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Pressure monitoring in powered support legs in selected longwalls at Jastrzębska Spółka Węglowa S.A.

This article presents the role of systems for monitoring the capacity of sections of the powered support forming part of mining complexes. It shows systems for monitoring powered support sections during the mining of coal deposits and the method of transmitting measurements of pressure in hydraulic legs to the analytical system used at Jastrzębska Spółka Węglowa S.A. The results of an evaluation of the interaction between the powered support and the rock mass and the manner of their presentation are provided.

Key words: *mining, powered support, capacity*

1. INTRODUCTION

Jastrzębska Spółka Węglowa S.A. (JWS S.A.) comprises five hard coal mines in which coal seams are exploited with the use of modern mining complexes. Powered support is one of the primary components of the said mining complexes, determining the safety of employees and the stability of the longwall working and thereby ensuring an appropriate mining level [1]. The principle of operation of powered support provides for a controlled reduction of the support when it is loaded from the side of the roof by a force arising from the capacity at yield of the support itself. Capacity at yield is a parameter that defines the boundary capacity of the powered support to carry pressures coming from a roof opened by mining operations. It is measured as the pressure of roof rocks on a single support section, which generates such pressure in the hydraulic legs that is equal to the setpoint on the valve blocks protecting the said legs [2, 3]. It is obvious, thus, that it is the control of the said pressure that is extremely significant in the coal seam mining process. These systems help advance the sections and permit the visualization of parameters such as: pressure in section's hydraulic legs, time of measurement performance, time of running of process engineering operations, moments of occurrence of irregularities or failures. At present, monitoring systems at JSW operate on several longwalls and, ultimately, they are supposed to be used on all of them. It must be noted that such systems are expensive and, for this reason, powered supports operating in the harshest geological conditions are the first to be equipped with them [4].

2. DATA ANALYSIS

JSW S.A. has been operating a Sophisticated Data Research Center for several years. It is tasked, among others, with analyzing process engineering data based on an integrated IT system for managing data coming from production processes, which comprises a Central Process Engineering Data Server (CSDT). The system is based on a platform that enables real-time processing of large information sets and easy integration with business systems, at the same time providing ICT security of physical systems. Data from all longwall shearers which are covered by systems for powered support section monitoring are transmitted to CSDT and processed for the purpose of gaining a broad evaluation of the interaction between the powered support and the rock mass. Such information is determined based on the pressure present in the legs of the powered support section. The obtained results are presented and reported to the relevant mine service staff.

3. MINING OF DEPOSITS

The mining of underground coal deposits by means of a longwall system employs a mining complex comprising among others powered support, the primary task of which is to ensure the longwall working stability and crew safety. One of the key actions to improve work safety and allow an increase in the production effectiveness is the evaluation of operation of the relevant powered support. When analyzing the interaction between

the powered support and the rock mass, certain aspects exerting significant influence on the longwall working stability can be determined. A loss of working stability results in a roof fall or caving in the longwall, which may be related to the following irregularities in the operation of powered supports [5, 6]: incorrect selection of sections for specified geological and mining conditions, failures of (damage to) individual components of sections, incorrect handling (use) of sections and incorrect geometrical form of the section structure. Owing to the monitoring of the section's operating cycle [7, 8], information may be obtained that refers, among others, to both the damage in the capacity part of the section's hydraulic system or the incorrect capacity at set value [9] and to the rock overhangs behind powered support sections that cause a considerable increase in the section load by the rock mass [10–12]. A view of a section with a data transmission system is presented in Figure 1.

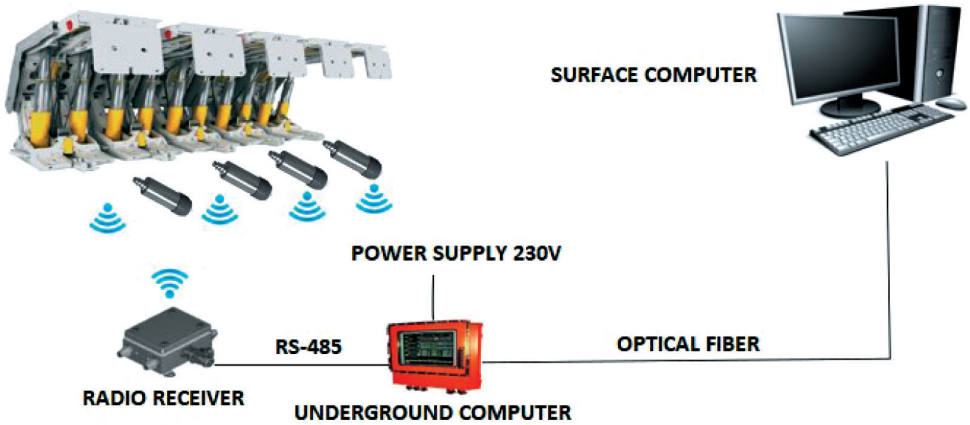

Fig. 1. Powered support capacity monitoring system

4. MEASUREMENT SYSTEMS

For the purpose of ensuring the correct conditions of roof maintenance and the operation of powered support sections, they are equipped with appropriate measurement and signaling systems. At present, pressures in the parts under the pistons of the primary legs of powered support sections are measured and recorded, and then this information from the monitored longwalls in JWS's mines is sent to the Sophisticated Data Research Center.

Measurement systems allow local monitoring of support's operation with the use of computers adapted for use in underground conditions as well as on the mine's surface. Figures 2 and 3 present a view of the powered support section monitoring with the use of systems created by Centrum Hydrauliki DOH sp. z o.o. and the FAMUR Group.

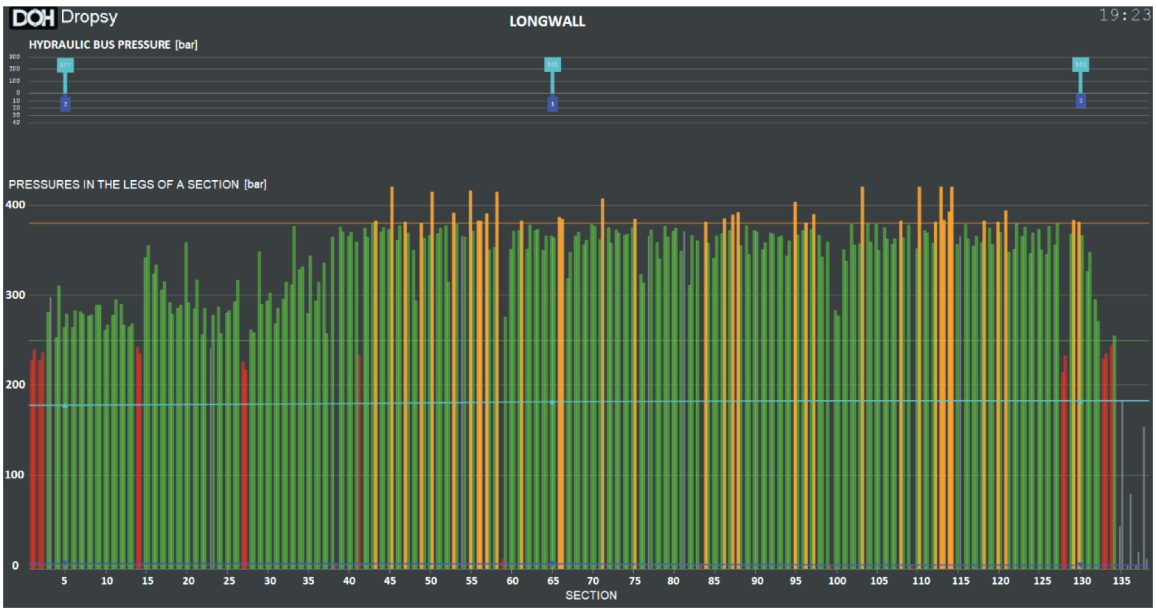

Fig. 2. Distribution of pressures in powered support legs – system created by Centrum Hydrauliki DOH sp. z o.o.

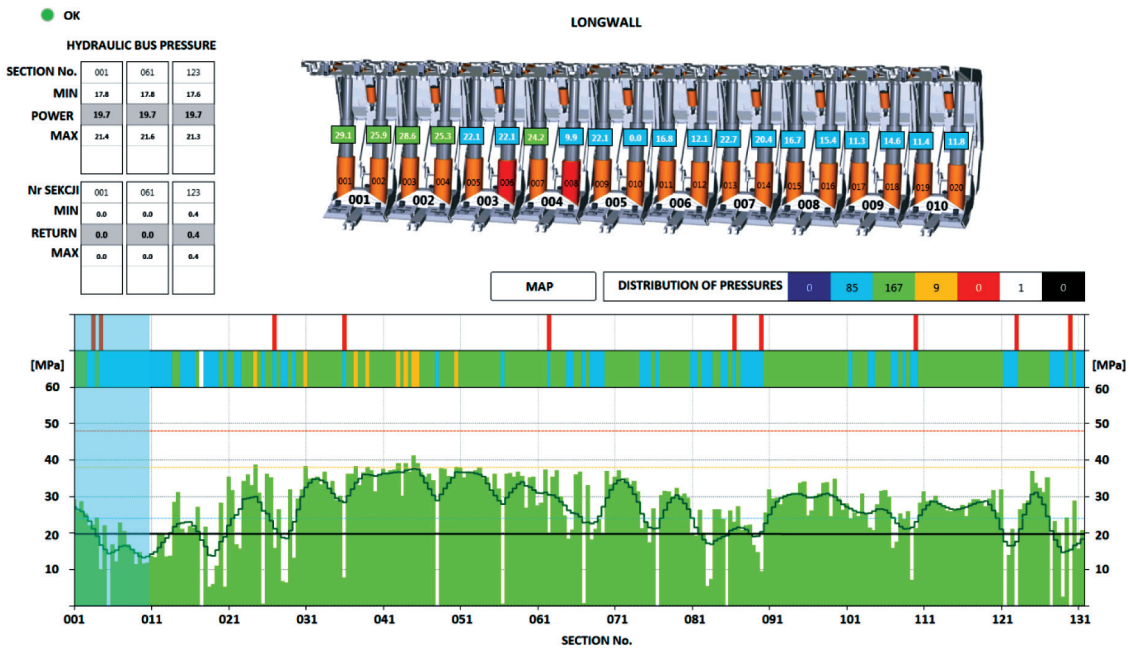

Fig. 3. Distribution of pressures in powered support legs – system created by the Famur Group

5. ANALYSES AND ALERTS

As a result of the analyses of pressure in the spaces under leg pistons, a range of events are identified in real time which require an appropriate reaction. Figure 4 reveals an asymmetry of pressures between the legs of a section, which indicates a leak in the leg's hydraulic system. This is visible after comparing with the correct powered support cycle in Figure 5. Figure 6 presents the tripping of a relief valve, which should trip on a specified pressure setpoint. It does not allow an increase in pressure above the permissible value specified by the section manufacturer. The following significant parameters are also identifiable based on pressure values: section withdrawal and expansion, and pressure in the main supply line [4].

It is important that the results of the analyses are delivered in real time and received directly by persons responsible for the proper operation of the mining complex – the mine's maintenance service staff. This is not simply due to the large production scale at JSW. This task was accomplished with the use of tools by OSISoft – PI System [13]. The basic information from a longwall shearer and from a single section is presented in Figures 7 and 8, respectively. The person who uses such information should very quickly evaluate the operation of the powered support section as regards its interaction with the rock mass. A summary of all alerts and important events occurring during the operation of powered support, i.e. an event map, is presented in Figure 9. It shows such events occurring on individual powered support legs for the last 24 hours as: operating cycles, asymmetry of support, repeated tripping of the relief valve, incorrect value of capacity at set.

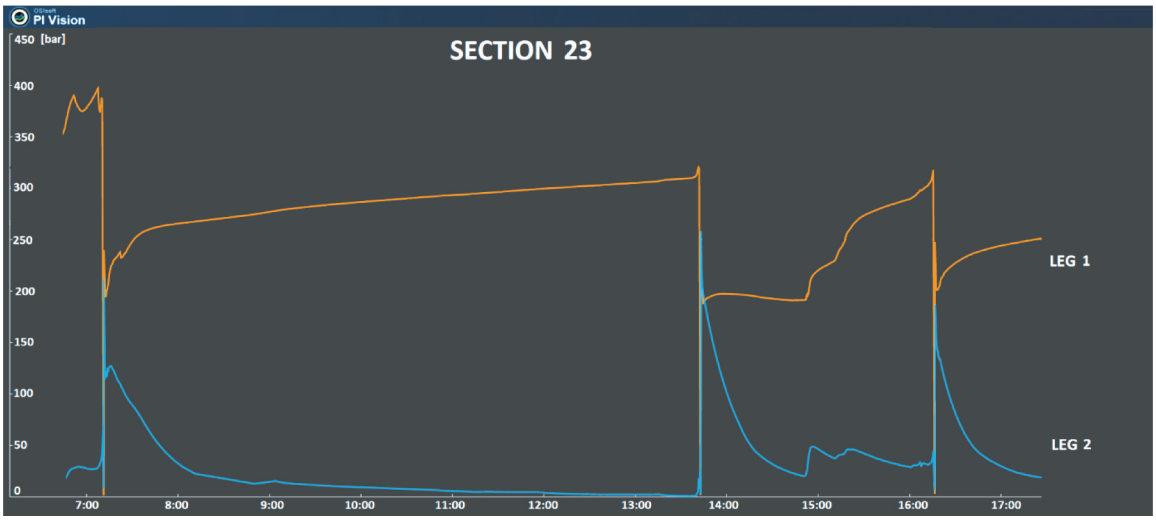

Fig. 4. Pressure asymmetry between section's legs

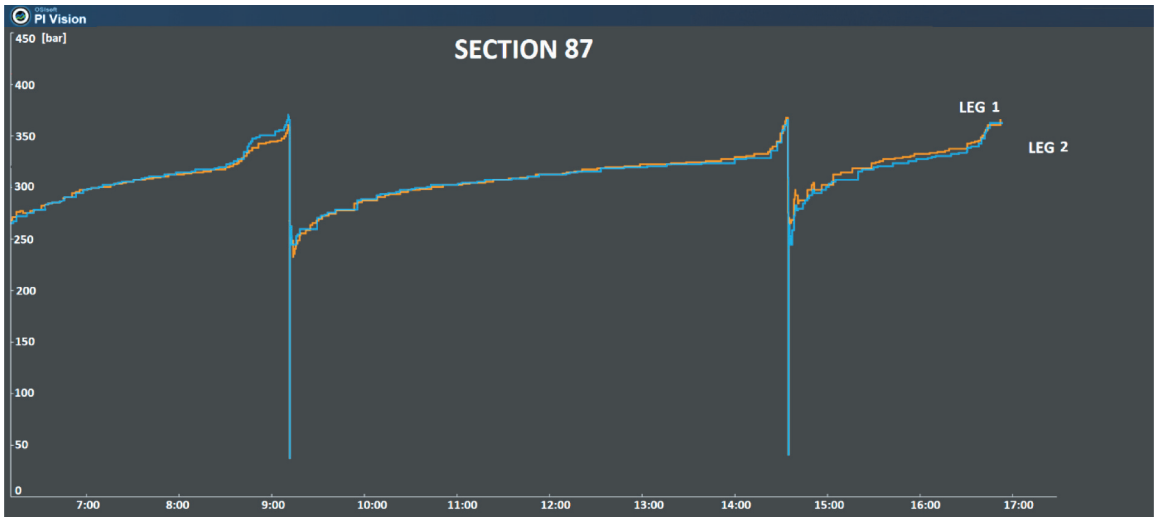

Fig. 5. Pressure measurement during successive operating cycles of the section

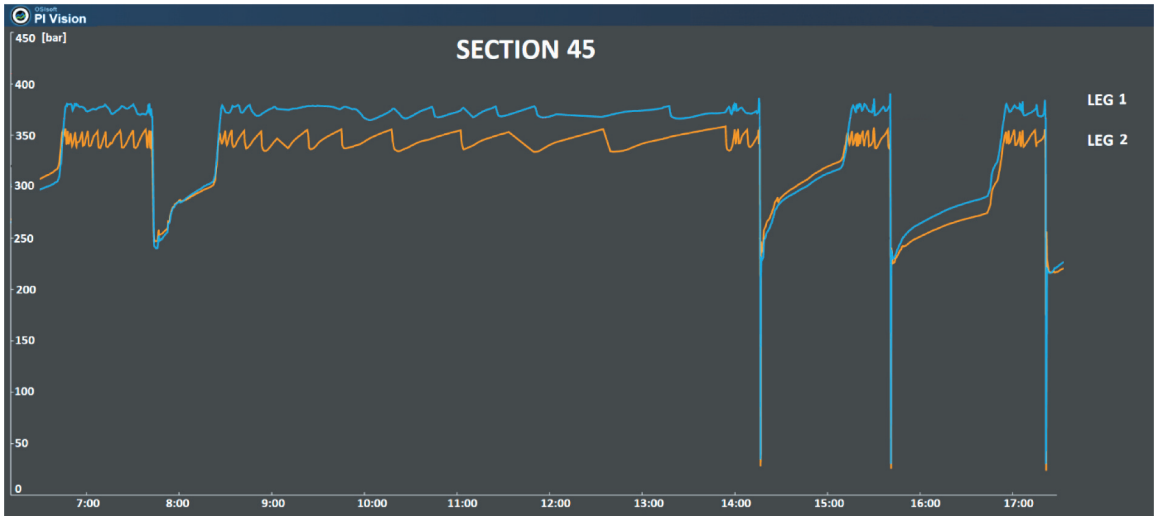

Fig. 6. Tripping of relief valve in section's leg

Fig. 7. Current view of pressures in powered support sections

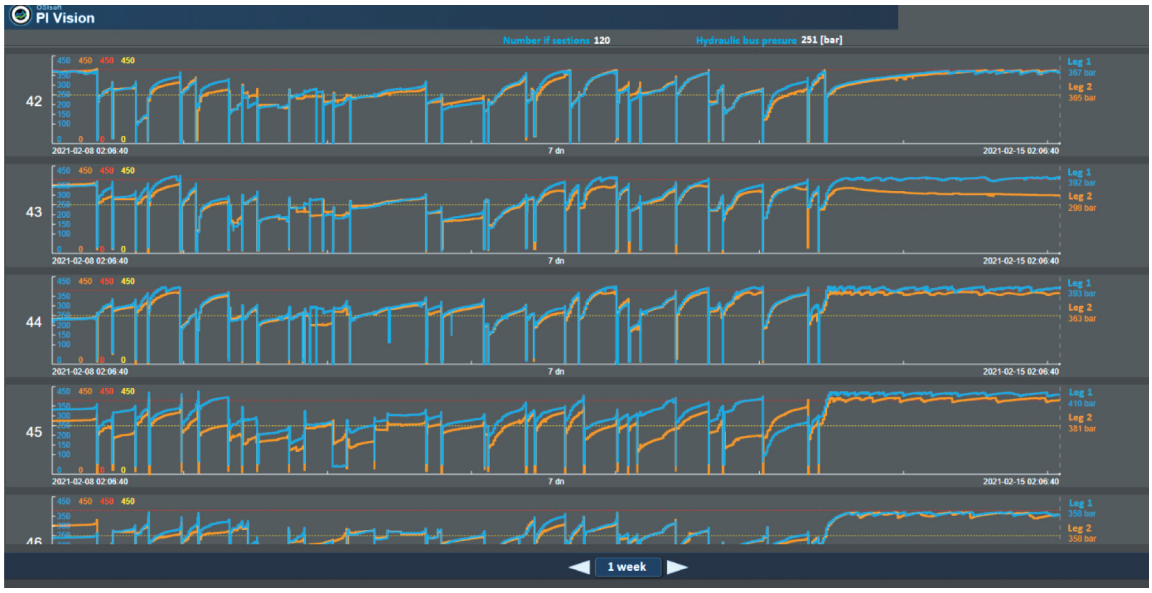

Fig. 8. View of pressures in selected sections

Fig. 9. Signaling of event occurrence in powered support sections

6. CONCLUSION

The implemented systems for the monitoring and analysis of section capacity enable a broad evaluation of the operation of powered support in the context of interaction with the rock mass. Due to the variety of factors affecting the support advancement, the interaction was evaluated by analyzing geological and organizational factors. The continuous control of capacity permits an evaluation of rock mass stress and a quicker reaction on the part of employees to achieve the correct state of rock mass equilibrium which has been disturbed during coal extraction. Such actions permit more effective remedial actions to be taken towards the impact of rock mass loosening (roof falls) during the course of mining. Work organization is a significant factor during support advancement. Owing to the monitoring of the section's operating cycle, information is obtained concerning, among others, the damage in the capacity part of the section's hydraulic system or the incorrect capacity at set value, or an overly long delay in supporting the newly uncovered roof, and the work culture of the longwall crew is improved.

The benefits achieved in this manner considerably improve crew safety and production effectiveness and extend the life of powered support.

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