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Geometrical Tests of Powered Roof Support Positioning in a Longwall Complex

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Abstract. A powered roof support protects people and equipment in the longwall from potential danger posed by the surrounding rock mass. The study to determine the position of the powered roof support was conducted in an active longwall. The research team made measurements of the geometric height of the powered roof support structure located in the longwall complex. The main objective of this study was to determine the position of the powered roof support in actual underground conditions. The analysis of the results provided data on whether the assumed height of the longwall was maintained during operation of the complex.

Keywords: Geometrical tests, Powered roof support positioning, Longwall complex

1. Preamble

The longwall systems used in hard coal mining are implemented with the participation of a longwall system which includes three main elements: a mining machine, a longwall conveyor and a powered roof support [1-10]. Powered roof support is an indispensable element of the equipment of the longwall complex. It is used to protect the space between the roof collapse line and the face of the solid coal [11-25].

In this space, there are devices necessary for operation and the movement of employees also takes place there.

The use of powered support is considered individually for a given longwall excavation. Determining the prevailing geological and mining condtions of the exploited deposit is necessary for selecting the support. Additionally, it is necessary to take into account the possibility of cooperation between the powered roof support and the machines and devices included in the elements of the longwall complex. This forces the design of sections with a specific technical configuration and a comprehensive determination of the geometric conditions of powered support operation [7, 9].

The aim of the article is to analyze the geometrical changes occurring in the transverse and longitudinal inclination of the powered roof support operation in underground conditions.

2. Characteristics of the research excavation

The tests were carried out in longwall IV in seam 405 which is located in the PI part of the mine. In relation to the ground surface, the wall begins its course to the west. It is exploited to the north and will end its course to the south-west. The launch of the longwall took place at the beginning of December 2020, while its completion is scheduled for the end of May 2021. The technical parameters of the IV-PI longwall in deck 405 are as follows:

- longwall length ~ 245-250 m,
- wall advance ~ 288-402 m,
- height longwall 3.4-4.4 m,
- exploitation depth 650-710 m.

As a result of the exploitation of longwall IV, the impacts ranging from I to IV mining area categories will appear on the ground surface. The maximum depressions of the area, reaching the value of 2.0 m, will occur in the undeveloped area to the west. There are the following natural hazards in the wall [26-29]:

Tab. 1. Characteristics of natural hazards in the tested longwall excavation.

Longwall	The type of hazards						
	methane [category]	rock bursts [degree]	coal dust explosion [grade]	water [step]	climatic	rock or gas outbursts [category]	fire
IV	I	-	B	I	-	-	IV

3. The sum of the slopes of powered roof support

Measurement tests were carried out in longwall IV to determine the longitudinal and transverse slope of the elements of the powered roof support of the Glinika 22/45 POz type. The measurement of the values made it possible to determine the sum of the longitudinal and transverse slopes of the powered roof support. The sum of the transverse and longitudinal slopes was determined by the formula:

$$\sum \lambda = (Sr\lambda_\alpha - St\lambda_\alpha) + (Sp\lambda_\alpha - O\lambda_\alpha) + (L\lambda_\alpha - S\lambda_\alpha) \cdot \frac{c}{2} \quad (1)$$

where:

$\sum\lambda$ - slope sum, [°]

$Sr\lambda_\alpha$ - slope roof timber,

$St\lambda_\alpha$ - slope hydraulic prop,

$Sp\lambda_\alpha$ - slope hydraulic actuator,

$O\lambda_\alpha$ - slope fender,

$L\lambda_\alpha$ - slope of the leminiscate,

$S\lambda_\alpha$ - slope sill,

c - constant of the calculation factor.

4. Determination of the slopes of the powered roof support in the mining excavation

The slopes were determined using a specially prepared measuring device, the collected measurements made it possible to determine the sum of the transverse and longitudinal slopes, which are illustrated in Figs. 1-2. The next Fig. 3 shows the changes in the value of the slopes in comparison with the height of the span of the support section.

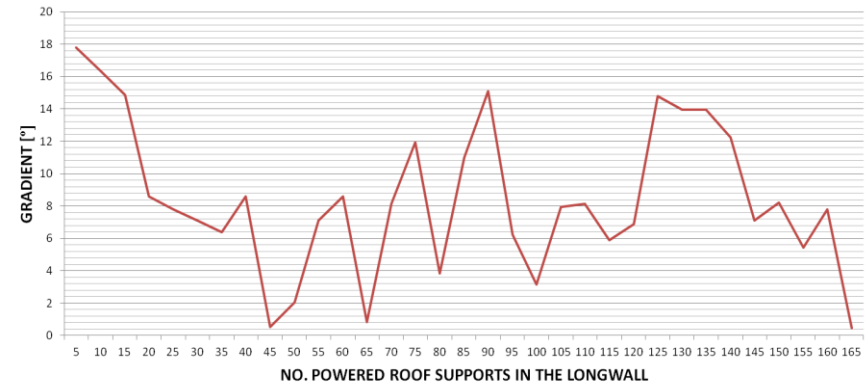

Fig. 1. Longitudinal Slope Graph - Manual Measurement.

The value of the sum of the longitudinal slope is determined by measuring the elements of the powered roof support, i.e. roof timber, hydraulic prop, hydraulic actuator, fender, leminiscate, sill. The measurements of the slopes of these elements are determined perpendicularly to the direction of the face of the longwall excavation, whereas the sum of the transverse slope is determined parallelly to the face of the wall. The method is shown in Figs. 4-5.

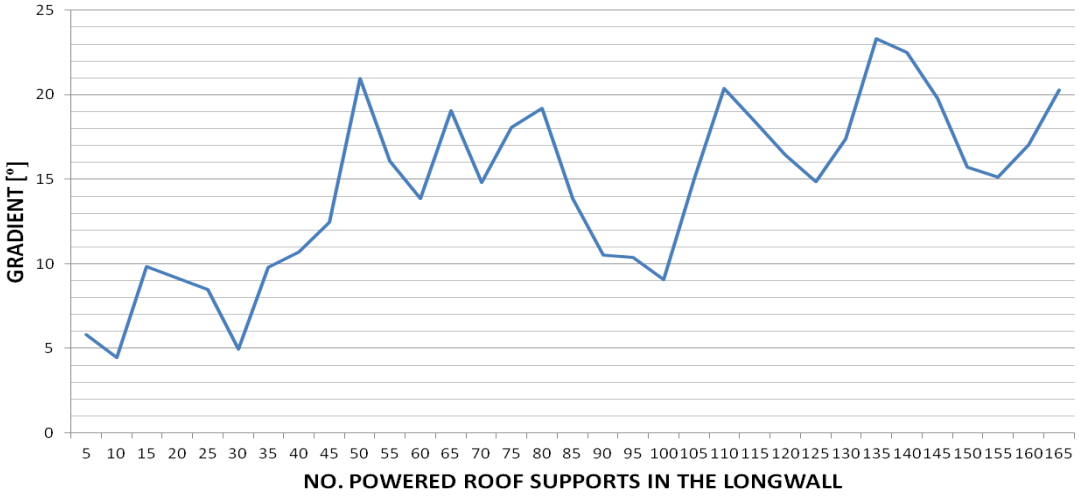

Fig. 2. Cross slope Graph - Manual measurement.

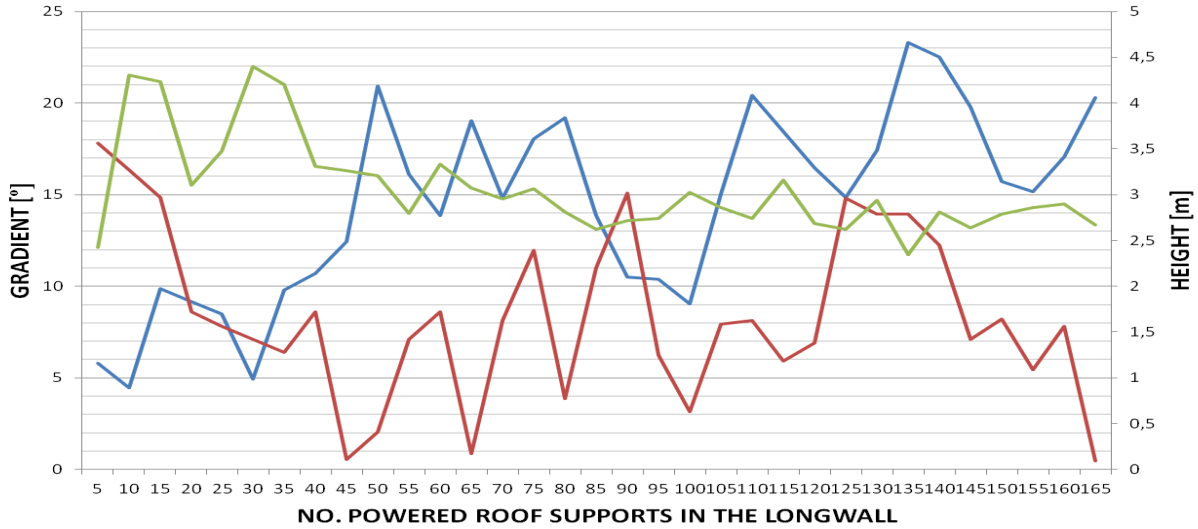

Fig. 3. Graph of the sum of the slopes and the height of the span of the powered roof support - manual measurement.

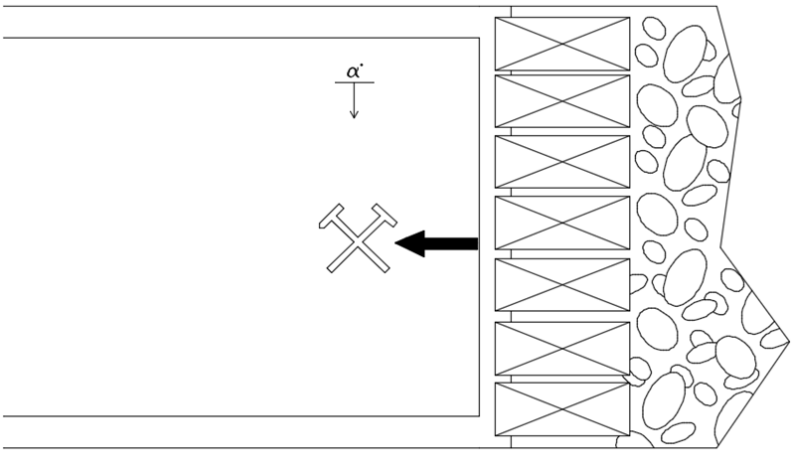

Fig. 4. Longitudinal slope. Own study.

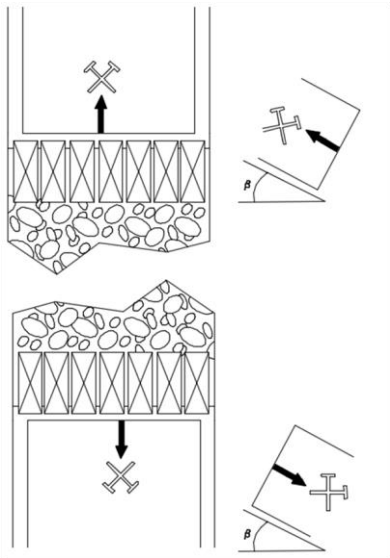

Fig. 5. Transverse slope. Own study.

The sum of the longitudinal slope changes by decreasing its value from 1 to 45 sections, then increases towards section 121. From section 121 to section 165 it decreases assuming a degree of slope close to section 45 of approximately 1°. The cross slope, similar to the longitudinal slope of 1 to 45 sections, changes its value, but in the opposite direction. The transverse slope in this particular working longwall adopts an upward trend. The value of the varying transverse slope has the greatest increase in the area of sections 130-135. The slope at this point is approximately 24°. The longitudinal slope changes its value from 18° to 1°, and the transverse slope increases from about 5° up to 24°. In the vicinity of section 85, the values of the sum of the slopes determine the common point with the superimposed values of the building height of the powered roof support. The slopes shown in the above charts in relation to the designated height of the expansion of the powered roof suport in the longwall jointly determine the geometry of the section development in the longwall excavation and the changing topography resulting from from mining and geological conditions.

5. Conclusion

With the help of the measurements of the slope of the mining excavation, we can determine: changes in the height of the wall, the degree of external impacts and the longwall complex development plan. The diagram shows that the wall lowers its height in relation to the longitudinal slope towards the over-panel walkway. The exploitation carried out under the slope conditions, which is illustrated by the graphs of the sum of the transverse and longitudinal slopes in longwall IV, can be classified as difficult or very

difficult. Such conditions force the user to use additional equipment in the powered roof suport in order to increase the work safety factor in the longwall excavation. The sections are equipped with, among others a pressure monitoring system and covers protecting against rock fall from the side of the side wall. Carrying out the extraction in a working with a variable slope significantly influences the efficiency of the excavation loading process and increases the power consumption of the drum and feed motor. The increasing slope in the longwall excavation generates changes in the manner of machine operation, operation and crew management. Determining the sum of the slopes of the powered support, which is one of the elements of the longwall complex, will contribute to the improvement of safety and efficiency of exploitation. Obtaining a measurable effect is possible by means of continuous measurement of the changes in the inclination of machines and devices, using systems supporting the monitoring of the slopes of the longwall complex.

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