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RESEARCH ARTICLE

THE COST AND EFFECT OF POWERED ROOF SUPPORT IN LONGWALL INSTALLATION COST

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ABSTRACT

Background:In longwall mining, for the purposes production and safety, the roof exposed in the working area of a longwall face must be supported and protected. For this purpose, hydraulic support units, which are called powered roof supports, are used in the production area. Before excavating the coal from underground, excavation area has to be prepared for longwall mining equipments such as powered roof supports, chain conveyor and shearer-loader. These are quite expensive equipments. In this study, importance of powered roof supports is evaluated considering it's unit cost in total costs. Equipment costs in longwall installation are specified according to equipment type. Total longwall installation cost is calculated and in order to mention importance of roof supports, percental value of powered roof support cost in total installation cost is calculated.

INTRODUCTION

Excavation of coal in the panel is an almost continuous operation in longwall production. High energy consumption governs the corresponding level of coal extraction. One of the underground coal extraction methods is longwall mining. This is a highly productive process for coal extraction with a high recovery rate. High-technology equipment and efficiency, mechanisability, and extraction of coal seams with high inclination and depth have made this process attractive for mining engineers (Deepak, 1986). Longwall is a mining method widely used in underground coal mines. It is the preferred method of mining a flat-lying stratiform ore body when a high area extraction ratio is required and a pillar mining method is precluded. The method is applicable to both metalliferous mining in a hard-rock environment and coal mining in soft rock (Peng and Chiang, 1984; Simsir, 2015). Nowadays, speed of supporting the roof has reached the excavation speed in longwall mining, so, the importance of powered roof support used in the face have increased. Powered roof supports are the most important equipment of fully-mechanized longwall mining in terms of providing a comfortable working environment, allowing rapid driving and production, and supporting transportation units (Yetkin *et al.*, 2016; Yetkin, 2016). Today, the increase of electric energy production from renewable resources can be observed, together

with the trys to limit the effect of traditional energy production technologies. However, in many countries coal continues to be the main source of energy. This paper deals with one of the aspects of underground coal mining which is the powered roof support. The main function of powered roof support is to provide the safety of work by supporting the roof after excavating the coal from the rock. The understanding of its working principle and modelling of roof supports it gives an opportunity for better machine operating, an increase of a work safety and decrease the cost of coal mining (Michalak, 2015). The cost of powered supports dominates other production costs in the longwall mining. Today, total cost of equipments required for longwall installation is approximately € 28 million and cost of powered roof supports comprise more than 50% of these costs. In this study, the effect of powered roof supports cost on longwall installation costs is investigated and results obtained are presented to researchers and engineers who work in decision-making positions in the companies.

Main Longwall Equipments

Longwall comprises a set of equipments which are listed below;

Longwall Shearer-Loader (Figure 1): The shearer-loader is used to extract coal seams from 1.8 m to 4 m for the extracting and the loading of coal on to the armored face conveyor (AFC). Seam thickness, which is appropriate for working of shearer-loader up to 7.3 m, has been achieved in today.

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Figure 1. Double-drum shearer-loader



Figure 3. Double chain armoured face conveyor

Powered Roof Support (Figure 2): The longwall face is supported by hydraulic roof supports whose main function is to provide a safe working environment as the coal is extracted and as the longwall equipment advances (Wiklund *et al*, 2011; Yavuz, 2015). Powered supports have come after a long development of steel supports in longwall faces (Barczak, 1990). Purpose of Powered Roof Support in Longwall Face: To ensure the safety of face crew, to ensure controlled roof caving, to prevent flushing of goaf material into the face, and to facilitate smooth functioning of longwall face. Face length decides the number of supports to be installed in the face (Yetkin, 2016). Cost of supports is nearly 70% of longwall package cost and this cost increases or decreases by face length.

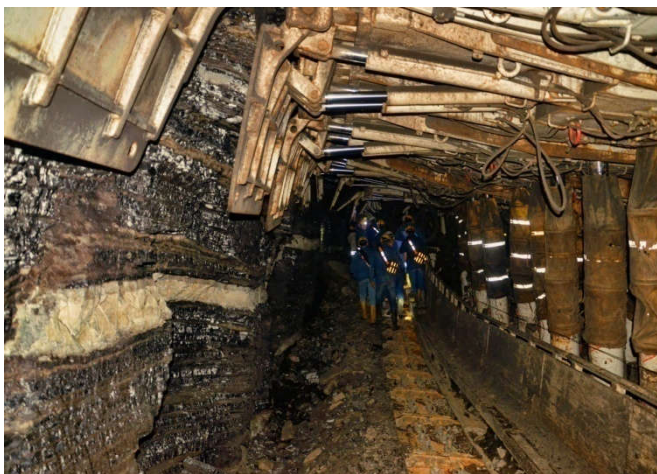


Figure 2. Powered roof supports in longwall face

Armoured Face Conveyor (AFC) (Figure 3): It transports a teared off material out of a longwall. Four types of armoured face conveyors are used: Single Centre (SCS), Double Centre (DCCS), Double Outboard (DOCS) and Triple Chain Strand (TCS). Length of armoured face conveyor changes according to face length, so, when the face length is increased, cost of face conveyor increases too. This equipment has as main function to haul the produced coal out from the face towards the main transportation gallery of the mine, and a first secondary function to act as a sliding way for the shearer loader, and finally, a second auxiliary function to be a rigid connection element for the support shields; the support shields, arranged along the face, realize the support of the face roof, and to control the gob laying down behind the face (Iliş *et al*, 2016).

Other Equipment: Roof Support carriers to carry hydraulic supports, Roadheaders for development of gate roads (main gate and tail gate) and other ventilation, roof support equipments of gate roads, Power Drive System, exploratory and blast hole drilling for gate roads and conveyor belts used to transport coal from AFC. Cost of other equipments comprise nearly 2.54% of longwall total unit cost.

Longwall Installation Cost Analysis

In today's longwall mining, production is made about 200 m face lengths. In the cost calculations, calculations are made considering the necessary equipments for a longwall which has 200 m face length and is operating with the remaining thick top slice of the seam is being caved and produced through folding gob shield located at the rear of the shields. Equipments required for the installation of a longwall and costs of these are given in Table 1.

Average of unit costs obtained from the different manufacturers is given in Table 1. When looking to Figure 4, to supply the coal demand that increases day by day, powered roof support capacity has increased year after year, hence, costs of powered roof support increase with this capacity increase. In 2011, powered roof support costs comprise 60.68% of the total costs in a longwall, which has 200 m face length, but today this rate has increased to 61.86% (Table 2).

Table 1. Longwall Equipments Costs

Longwall Mining Equipments	Number	UnitCost (€)	Total UnitCost (€)
Drumsherar-loader	1	2889831	2889831
Face support	110	141864	15605040
Transition support	4	197034	788136
Maingate support	2	570085	1140170
Face chain conveyor	2	1681356	3362712
Rear chain conveyor	2	1497458	2994916
Transmission conveyor	1	840678	840678
Panzer crusher	1	168136	168136
Hydraulic Pump Station + Hose System	1	394068	394068
Face Signalization and Communication System	1	157627	157627
Sum			28341314

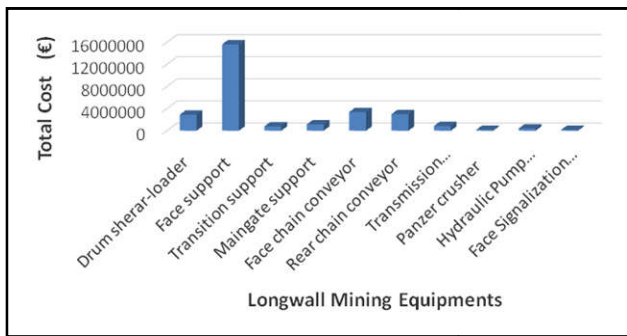


Figure 4. Distribution of unit costs according to equipment type

Table 2. Percentage of powered roof support costs in total cost

Longwall Mining Equipments	Number	Unit Cost (€)	Total Unit Cost (€)	Support Cost (%)
Face support	110	141864	15605040	61.86
Transition support	4	197034	788136	
Maingate support	2	570085	1140170	
Sum (Support Cost)			17533346	
Sum (Total Equipment Cost)			28341314	

When equipments in a which create longwall are evaluated, percental distribution of costs of these equipments in total costs is given in Table 3 and Figure 5.

Table 3. Percentaged distribution of main equipment costs in total cost

Equipment Type	%
Other equipments	2.54
Roofsupports	61.86
Armouredface conveyor	25.40
Drum shearer-loader	10.20
Total	100.00

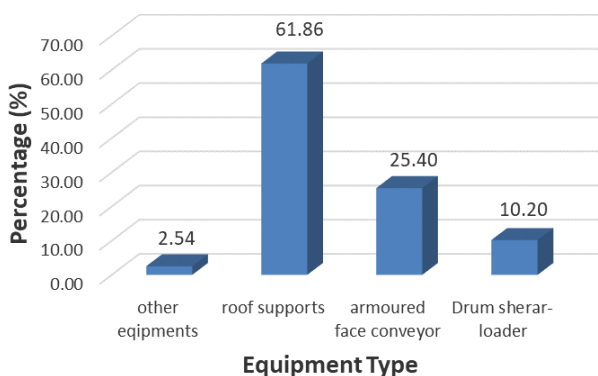


Figure 5. Percental distribution of equipment costs within total cost

Conclusions

Longwall is a production method which contains many engineering systems.

When considering economics and engineering, it is seen that one of the most important equipment of longwall method is powered roof supports. Equipment used for face signalization and communication system, hydraulic pump station and hose system etc. constitute 2.54% of total longwall costs, drum shearer-loader constitutes 10.20% of total longwall costs, armoured face conveyors constitute 25.40% of total longwall costs and powered roof supports constitute 61.86% of total longwall costs. In the study, it is seen that the powered roof supports which have 1st degree importance in terms of safety and production are the most important equipment in terms of economical reasons, too. For this reason, powered roof supports selected correctly and at the optimum capacity which are used in longwall is of great importance for companies.

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