

TECHNOLOGIES FOR THE DEVELOPMENT OF SLOT RAISE DURING THE FORMATION FREE SURFACE

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Abstract

Ore excavation by vertical cuts with horizontal advancement is carried out through blasting of drill holes arranged in fan pattern. Thus, the ore is fragmented through drilling and blasting. Before excavation begins, it is essential to create free space to accommodate the ore and the excess volume. The primary free surface is provided by developing a slot raise at the front part of the excavation. This paper presents various technologies for the development of slot raise that are currently used worldwide.

Keywords: slot raise, Alimak, raise boring, drilling and blasting

1. INTRODUCTION

Ore deposits are characterized by a variety of conditions and modes of occurrence, as well as the mechanical and structural properties of the ore and surrounding rock. In many cases, mining is conducted in solid rock environments, which requires the extraction of ore through drilling and blasting operations. Different mining methods are used for various types of ore deposits. For some methods, excavation begins with development of slot raise, which forms the initial free space needed for the successful blasting of the first sets of drill holes. Additionally, the development of the slot raise allows for the accommodation of the excess volume generated from the fragmentation of the blasted ore [1].

Slot raise is essentially a vertical or inclined underground drift that provides an initial free surface and suitable compensatory space. Depending on the technologies, it can have a square or circular cross-section [1].

Today, various technologies are used worldwide for the development slot raise, with the most common being long-hole blasting, manual drilling with hammers, and mechanized drilling. What all of these methods have in common is the complexity of the process, which involves numerous technological operations, leading to reduced efficiency. Each technology has its own advantages and disadvantages, and the choice of the appropriate one depends on factors such as geological conditions, the required dimensions of the slot raise, costs incurred during the development process, safety considerations, production requirements, etc.

2. EXPERIMENTAL

2.1. Alimak raise climber technology

Self-propelled raise climber “Alimak” operates of the principle of rack and pinion transmission along a specially designed guide rail, anchored with rock bolts. A system of pipes for supplying compressed air and water for drilling is integrated into the segments

of the guide rail. This system also provides ventilation for the slot raise after the blasting process [2].

The drilling of blasting holes and their charging with explosives is carried out from the platform of the raise climber, which features a specially designed safety roof (Figure 1). Compressed air and water for drilling, as well as for the operation of drilling hammer, are supplied through pipes integrated into the guide rail.

After drilling, charging with explosives and preparing the worksite for blasting, the raise climber platform is lowered to the starting station in the horizontal underground drift. This ensures that the platform is protected from the impact of blasted material during blasting process.

At the end of blasting phase, slot raise is ventilated and flushed with a mixture of air and water supplied through pipes in the guide rail. After ventilation is completed, the climber platform is raised, and the process of tapping the roof and sides of the worksite to remove rock begins. Following the securing of the worksite, the guide rail is extended, and drilling of blasting holes resumes [2].

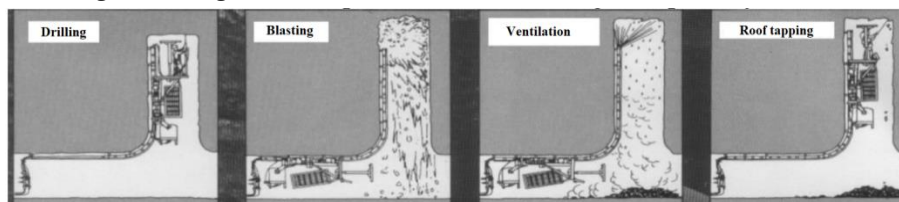


Figure 1. The process of slot raise development using the “Alimak” system

With the Alimak platform, it is possible to develop long slot raise at various inclinations, with a high level of safety and process efficiency. However, this technology requires the construction of additional chambers to accommodate the complex equipment, which further increases costs and significantly influences the choice of slot raise development technology [2,3].

2.2. Mechanized slot raise development - RBM

The raise boring method (RBM), takes place in two phases (Figure 2). First, a pilot (guide) hole is drilled from top to bottom. The debris generated during this process is removed from the face of the hole using an appropriate fluid (mud). Once the pilot hole breaks through to a lower level, the drill bit is removed from the drill pipes, and a larger diameter cutting head composed of several smaller cutting elements is mounted [4].

The expansion of slot raise is carried out by rotating the cutting head and applying pressure to the rock as the drill rods are pulled upwards. As the work progresses, the drill rods are disassembled and removed at the higher level until the slot raise is completed. The debris generated during the process falls by gravity to the lower level, from where it is loaded and transported further [4].

By applying the raise boring method, higher production speeds are achieved, along with the development of slot raise with a more regular cross-section compared to traditional methods. This technology does not involve the use of explosives, thus avoiding the generation of harmful and toxic gases produced by blasting. However, high cost of equipment, the complexity of site preparation and equipment relocation are some of the reasons why simpler construction technologies are often preferred.

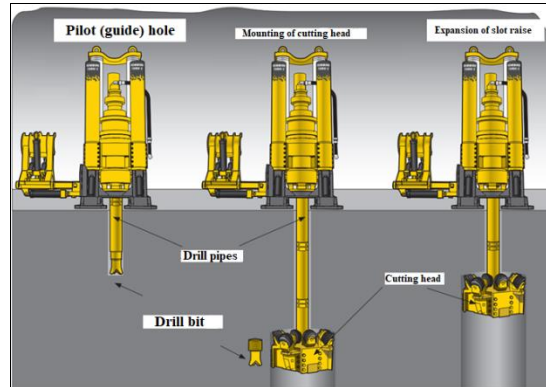


Figure 2. The process of slot raise development using raise boring machine

2.3. Drilling and blasting

The critical point in excavation by vertical cuts is the development of slots, i.e., the primary free surface. In decades of mining practice, slot raise has most commonly been developed through drilling and blasting operations. Development slot raise with long blasting holes is analogous to development slot raise with short blasting holes when blasting is conducted with one free surface. In such cases, the entire slot raise can be completed with single blasting operation. The main challenge in the development of slot raises using this method is the deviation of blasting holes. The layout of the blasting holes at the breakthrough level can significantly differ from the layout at the drilling level [5].

To enhance the effects of blasting and achieve slot raise with the desired shape and dimensions, the described technology has been improved. The new approach to the development of the slot raise involves two-stage blasting. First, the lower half of slot raise is blasted, and then the upper half. Blasting holes are drilled vertically downward with drill rig, following a specific pattern (Figure 3). Once drilling is complete, deviations in the holes are recorded, and the blasting sequence is planned. Initially, blasting holes in the central part are detonated to development free space, which allows for the subsequent blasting of the side blasting holes. After blasting and ventilation, demined material is loaded. The upper half is blasted in the same manner. Based on data regarding blasting hole deviations, it is necessary to adjust the sequence for initiating the blasting holes [6].

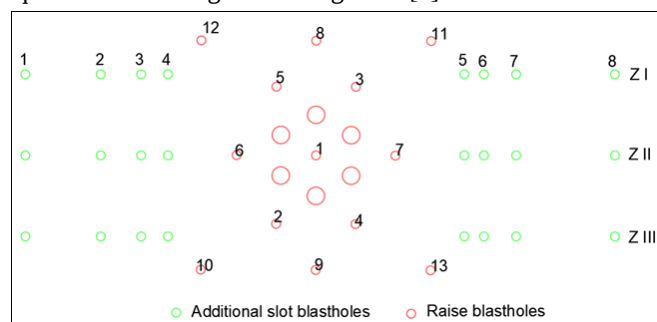


Figure 3. Slot raise blastholes pattern



Drilling and blasting works are the most traditional technology for the development slot raise, offering high adaptability to various geological conditions. Additionally, it is often more economical than other technologies as it does not require the purchase of specialized, expensive equipment. However, the use of explosives poses risks, including unforeseen explosions, collapses, and the generation of harmful gases, which can impact the stability of the slot raise and surrounding rock mass.

3. DISCUSION AND CONCLUSION

In this paper, various technologies for development of slot raise have been analyzed, including those using drilling and blasting operations, the Alimak raise climbing platform, and the raise boring method. Each of these technologies has specific advantages and disadvantages that are directly related to geological conditions, slot raise construction, as well as economic and safety factors. For the proper selection of the technology, it is necessary to carefully consider all relevant factors in order to choose the optimal technology from the perspective of costs, efficiency and safety. The constant progress of techniques and technology, as well as the research of new methods, can contribute to the improvement of existing development technologies, which will significantly impact the modernization of underground mining.

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