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Design and Research on a New Type of Mine Roadway Safety Support Device

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Abstract: In the development process of the mining industry, tunnel excavation and support technology has been widely applied, which not only ensures the safe and stable progress of engineering, but also improves engineering efficiency. This article mainly focuses on the field of underground mine roadway safety and proposes an innovative method for mine roadway safety monitoring and support design. This method achieves targeted adjustment and optimization by deeply studying the characteristics of rock layers, effectively improving support stability, further strengthening mine safety, and providing more solid support for workers.

Keywords: Mining engineering; Mine roadway; Support technology

1. Research Background and Significance

With the acceleration of global industrialization, the demand for mineral resources continues to rise, and mining activities become more frequent. However, in the process of mineral resources development, the safety problem of mine roadway is always a major problem affecting the production benefit and personnel safety. Traditional support equipment often has a single function, which cannot be real-time monitored and effectively supported. Therefore, in the complex and changeable mine environment, the roadway is prone to displacement, deformation and even collapse.[1-2]

In view of the above problems, it is urgent to carry out relevant research and design an innovative mine roadway safety support equipment. The equipment not only requires real-time monitoring of mine roadway, but also needs automatic support function, so as to effectively improve the safety and stability of mine operation.[3] In addition, with the rapid progress of sensor technology, data processing technology and automatic control technology[4], the application of these technologies to the design of mine roadway safety support equipment is expected to bring unprecedented breakthroughs and innovations in this field.

The existing data of mine roadway support system mainly relies on manual regular collection, which has some limitations in terms of real-time, collection period and accuracy of data analysis.[5] In the application process of roadway support structure, we often encounter the disorder and entanglement of wire and cables. This practice not only has a negative impact on the arrangement and maintenance of wire and cables, but also increases the safety risk of personnel in the process of roadway operation.

“Roadway support technology has a crucial impact on the safety, yield and efficiency of mines. “In view of the above problems, we have developed a new type of mine roadway safety monitoring and support equipment. This design scheme not only effectively solves the problem of wire accumulation, but also improves the stability and durability of the supporting structure, so as to ensure that the staff work in a safer environment, and provide a more reliable guarantee for their life safety.[6] Using the support inspection instrument, we can monitor the roadway safety indicators in real time, and implement dynamic control of the support device according to the monitoring data, so as to ensure the accuracy and timeliness of the support monitoring information, so as to improve the automation level of mine support management.[7]

The core goal of this study is to design and explore an innovative safety support equipment for mine roadway, aiming to provide technical support for the efficient development of mineral resources, and to protect the life safety of mine operators.[8]

2. Mine Support

The original rock stress field is in a three-dimensional equilibrium state. After the roadway excavation, the appearance of the free surface in the rock mass causes the redistribution of the ground stress, and then forms the secondary stress field of the surrounding rock. When the surrounding rock itself cannot withstand the stresses it bears, and the support resistance of the external supporting body is not enough to offset these stresses, the roadway will begin to deform until the final destruction. [9]In the process of implementing the tunneling technology,

after the ore passes through the blasting and loading link, the corresponding transportation equipment is transported, so as to realize the continuous operation mode. Tunnel tunneling is a complex giant system engineering, planning and organization is crucial. After the space stripping of the rock layer, the roadway support measures should be implemented in time to lay the foundation for the later construction.

In the support technology, a variety of materials can be selected, such as metal, reinforced concrete and wood. However, the bolt technology performs well and has a high priority. The construction of the wooden support is convenient, but the fire prevention performance is not good, and the bearing capacity is weak. Reinforced concrete has the advantages of low cost and small resource consumption, but it lacks expansion performance and large weight. In contrast, the metal bracket has good reuse, disassembly convenience, and strong durability, suitable for short-term use scenarios. Stone supports have high strength and durability, but the cost of concrete is relatively high. In contrast, the mortar support adopts the mixture injection method, showing a good effect.

The implementation of active production safety guarantee measures is helpful to eliminate the safety risks in the mine production process and ensure the safe and stable implementation of production activities. This move will not only help to ensure the stability of the mine operation surface, improve the safety performance of mining and transportation equipment, but also improve the overall production efficiency. The protection of miners' life rights and interests lies in creating a safe and stable working environment and reducing the possibility of accidents.

3. Design Content

The design of safety support device for high strength adjustable roadway in mine aims to overcome the problems of existing technology. The design mainly includes the following key parts: base, supporting column, horizontal bar, curved top, connecting column, first fixed column, fixed block, rotating wheel, rotating rod, rotating bar, second rotating shaft and handle. The upper surface of the base is closely connected to many support columns, which are stably connected to the horizontal bar. The top of the bar further fixed the arc top, while the top of the bar is firmly connected to the connecting column. The outer surface of the connecting column is tightly fixed to a plurality of first fixed columns, which are closely embedded in the inner wall of the supporting column and form a rotational connection away from the one end of the supporting column. The side wall of the rotating wheel is tightly locked with the rotating rod to ensure its stable connection, the top of the rod is closely connected to the second shaft, and the external surface of the second shaft is rotating installed with the knob.

This design scheme is rigorous and thorough, and implements the efficient arrangement and storage of the internal wires of the roadway, so as to facilitate the subsequent maintenance and management. The whole structure is stable, has excellent drainage function, and effectively prevents the equipment from getting rust. In the design link of the top of the base, we set a number of fixed support columns, and assembled the corresponding horizontal bar on the top of it. The top of the horizontal bar further connects the arc top to the connecting column. The arc roof design is beneficial to support the top of the roadway, while the connecting column helps to enhance the stability of the whole device. On the outside of the connecting column, a plurality of first fixed columns are provided to improve the overall stability. One end of these first stationary columns is tightly connected to the upper surface of the horizontal bar, thus ensuring structural stability. The lower surface of the horizontal bar is closely connected to a plurality of connecting rods, which are provided with a first rotating shaft and an outer surface equipped with a fixed pulley. This design subtly adjusts the movement path of the rope, thus enabling the movement of the wire fixing plate upward. Front view of the device design, as shown in Figure 1.

The main structure is composed of the following parts: supporting column, fixed block, rotating wheel, rotating rod, second rotating shaft, handle, rope, wire fixed plate, base, slide, guide, drop sink, horizontal bar and second fixed column. On the inner wall of the support column, multiple fixed blocks are located at the end of the support column away from the rotating wheel, to which rotational connections are made. The rotating rod is firmly mounted on the side wall of the rotating wheel, and the top of the rotating rod is firmly connected to the second rotating shaft. On the external surface of the second rotating shaft, the surface of rotating the connecting handle is provided with anti-skid lines to improve the convenience of rotating operation. The external surface of the rotating wheel is stably connected to the wire fixing plate by the rope, which helps in the safe storage and arrangement of the wire. The outer surface of the rope fits closely to the outer surface of the fixed pulley. The top of the base is equipped with a convex platform for fixed connection, and the convex platform section appears as an

obtuse triangular design. The top of the base is equipped with a slide and water guide tank, which is conducive to the layout and installation of drainage facilities. The support column is equipped with a drainage tank on the outer surface of the arc top, which acts in synergy with the slide to ensure excellent drainage performance. The edge of the horizontal bar is closely connected to several second fixed columns, and one end of these fixed columns is far from the horizontal bar and firmly combined with the upper surface of the base, thus effectively improving the stability of the equipment.

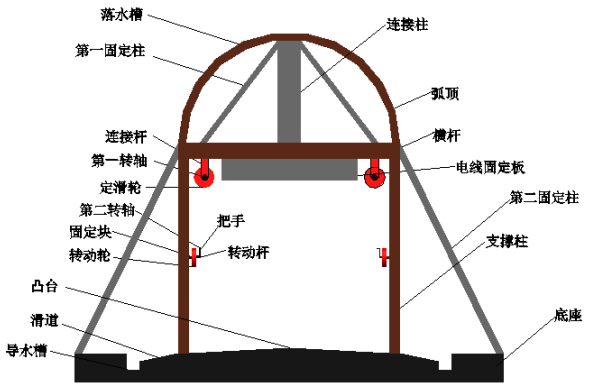

Figure 1 Face to face design of safety support device for new mine roadway

4. Design Principle

When controlling the design device, the handle should be placed in a horizontal position to activate the rotating wheel and ensure the wire of down. The wire is then placed in the fixing plate, followed by the handle in reverse to move the fixing plate upward, thus fixing the wire in the top position. The aim is to avoid chaos in the layout of the roadway. With the help of the curved top design, the equipment can provide effective support for the top of the roadway, so as to ensure the stability and safety of the roadway structure. The configuration of connecting column, first fixed column and secondary fixed column enhances the stability and firmness of the equipment. At the same time, the design of the convex table endows the equipment with the function of guiding the water flow in the roadway to the slide, so as to realize the effective discharge of the water flow and reach the water guide tank. The configuration of the drop tank ensures that the water from the support column and the curved top is discharged quickly, thus preventing corrosion problems caused by long accumulation on the equipment. The 3 D design diagram of the device, as shown in Figure 2.

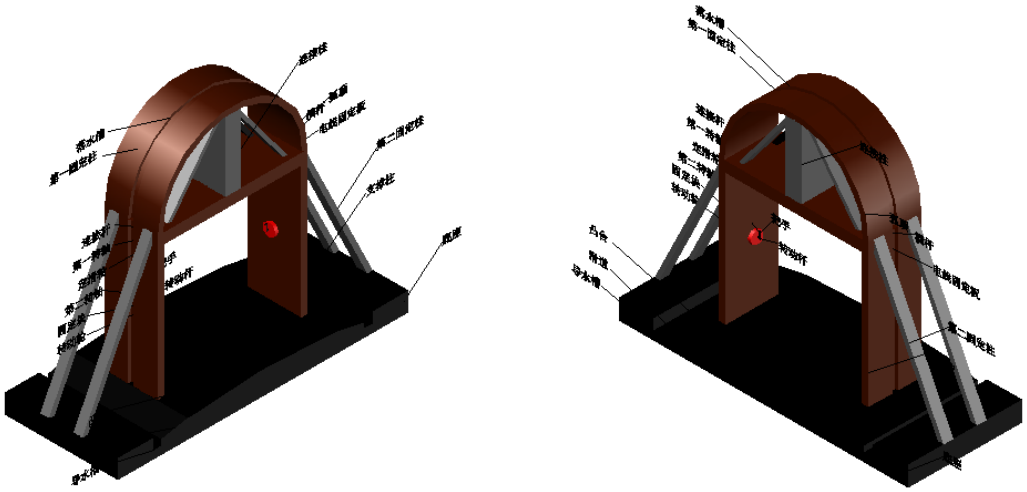

Figure 2 The 3 D design drawing of the new mine roadway safety support device

5. Conclusion

In the construction process of tunneling and support engineering system of mining engineering projects, the core goal is to realize efficient, environmental protection and sustainable industrial development and comprehensively improve the overall efficiency of coal mining production system by optimizing the equipment, adjusting the production process and improving the mining technology. The roadway safety support device of the mine roadway shows excellent stability and rationality in the structural design, and can efficiently arrange and store the wires inside the roadway, so as to facilitate the maintenance and arrangement. In addition, the equipment has excellent overall performance, which can effectively eliminate the moisture inside the roadway, thus preventing the corrosion of the equipment. However, in practice, the continuous optimization and improvement of new supporting devices are still necessary to adapt to various complex environments and conditions. In addition, the research on the potential application value of the device in other fields is expected to provide technical support for production safety in multiple industries.

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