

Construction Safety Management and Construction Technology of Low-gas Tunnels

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Abstract: With the coordinated development of social economy and technology today, various advanced construction techniques and well-established management measures have begun to be widely used in coal-tunnel construction. However, in the construction process of low-gas tunnels, it will also cause a certain degree of adverse impact on the construction quality and safety due to the lack of technical experience and management experience to a certain extent. Based on this, this paper takes the actual tunnel project of a coal mine as an example to analyze the main construction technology and safety management measures of low-gas tunnels, so as to provide guarantee for the quality and safety of such tunnel construction.

Key words: Low gas; Tunnel construction; Construction technology; Safety management

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1 Introduction

With the continuous development of coal industry, the main construction technology and safety management in the construction of low-gas tunnels have begun to receive more and more attention from the society. Therefore, in the specific construction of low-gas tunnels, coal companies should strengthen their safety management and rationally apply their construction

techniques. In this way, the construction quality of low-gas tunnels can be effectively improved and construction safety can be guaranteed.

2 Project overview

The subject of this study is the construction of a low-gas tunnel in a coal mine. The mine is located in the western part of the Sichuan Basin. It is of lowland mountainous feature with a shallow to mid-cut structure, where the Longquanshan anticline has a greater impact on it. In this mine, most of the mountains are multi-faceted, relatively gradual, and the mountain tops are saddle-shaped or hump-shaped, rich in flammable gas in the cracks of rock mass and sandstone mass. Through the initial exploration, it was found that there was flammable gas overflow in the BK255700L20 borehole of the B-line of the tunnel under construction. The ignited flame was about 20-30cm higher than the hole, and it extinguished by itself after burning for 5 minutes^[1]. After detailed survey, it was discovered that when the hole depth of the tunnel line of BK255700L20 reaches 128m within the sandstone section, there will be flammable gas overflow. Its main component is methane and the pressure is about 0.12MPa. Such gas is usually found to accumulate in rock mass and sandstone cracks. From this, it can be determined that this mine tunnel is a low-gas tunnel. The following picture shows the actual shot of the low-gas tunnel construction:



Fig.1 The Actual Shot of the Low-gas Tunnel Construction

3 Analysis of main safety construction technology for low-gas tunnel

3.1 Gas inspection technology

The first is manual inspection. In this process, professional inspectors need to inspect the methane and carbon dioxide concentrations in the tunnel, and make detailed records of the inspection data, and finally report the inspection results to the safety director of the project department.

The second is the determination of the gas detection site. In the specific detection, the monitoring point can be allocated within 20m of the excavation surface, the dead corner in the cave, the front of the lining work trolley, the excavator, the loader, and the front of the tunnel car, switch and spot welding positions near the ventilator or in the hole, avoiding people or vehicles in motion, and other locations with poor ventilation. For each monitoring point, the gas inspection record board should be clearly put up, and each inspection result should be recorded on the record board and the corresponding record book in time, and then the inspected conditions should be reported to the manager^[2].

3.2 Low-gas tunnel blasting technology

First of all, check the following items: First, technicians need to check on-site electric lightning, explosives and other pyrotechnics every day to ensure that the charging structure is consistent with the drilling and blasting design. Second, management personnel should conduct spot checks on the connection construction of blasting nets, plugging, and charging. Third, before the blasting operation, safety inspectors need to check the gas concentration at the blasting sites every day. Fourth, after the blasting, safety inspectors need to check the gas

concentration, ventilation and coal dust at the blasting sites every day.

Before blasting, it is necessary to do a good job in the safety education of construction personnel, and strictly implement the two systems of "one shot, three inspections" and "three-person chain blasting". In tunnel drilling, drilling is mainly carried out in the form of wet drilling, and it should be carried out in the order of boiling water first and then air. In the wind flow within 20m of the operation site, the drilling operation should be stopped immediately if the gas concentration reaches 1%. Before excavation and tunneling construction, it is necessary to fully understand the actual geological conditions ahead through advanced survey. If there is a coal seam, the construction must be carried out by uncovering coal and preventing outburst. During the construction process, the inspection of gas concentration and ventilation should be enhanced, and the construction of advanced probing holes and deepened blastholes should be strengthened. In the specific blasting operation process, safety inspectors and gas inspectors need to jointly inspect the blasting site and do a careful inspection on the residual charge, unexploded charge, coal dust, gases and ventilation etc. 30 minutes after the blasting is finished. If an unusual situation is discovered, it must be handled properly immediately. If the gas concentration in the tunnel is within 1% and the carbon dioxide concentration is within 1.5%, the alert can be lifted, and then the construction personnel can enter the tunnel face to start work.

3.3 Ventilation operation

Before starting the construction of the low-gas tunnel, to ensure that each operation site has good ventilation, the operator needs to check the ventilation effect of each operation surface to ensure good ventilation. The ventilator bracket must be installed firmly to avoid shaking and falling off due to vibration during operation. At the outlet of the fan, the connection should be made through a rigid air-duct, and a gasket should be installed between the air-duct and the flange at the fan interface. At the position where the flexible duct and rigid duct are combined, three-to-one banding should be carried out to reduce local resistance and air leakage. For each working surface of a gas tunnel, independent ventilation must be ensured.

During the construction process, the continuity of ventilation must be ensured. If the ventilation has to be stopped due to power outages or overhauls, the construction personnel must evacuate from the tunnel in time and cut off the power supply. Before the ventilation is restored, the gas concentration inside the tunnel must be checked. The press-in fan is used in this project. In the specific inspection, the gas concentration within 10m of the fan must be ensured to be below 0.5% before the ventilator can be turned on manually. For the ventilation ducts inside the tunnel, a duct with good flame retardancy and antistatic properties must be selected. When the distance between the opening of the ventilation duct and the tunnel face is not more than 5m, it is strictly forbidden to remove the tunnel face duct during blasting.

During the installation process of the press-in ventilator, it should be placed in the fresh air flow of the tunnel to prevent the circulation of dirty air in the tunnel. For the ventilators inside the tunnel, two power sources should be available, and a wind power-locking device should be set up. If one power supply halts, the other power source can supply in time to ensure the normal operation of the ventilators.

4 Analysis of safety management measures for low-gas tunnel construction

In the low-gas tunnel construction of this project, safety management is mainly carried out through the following measures.

(1) The concentration of harmful gases in the tunnel shall be inspected by specialized gas detectors in accordance with specific requirements. Meanwhile, special attention should be given to the locations of excavation bumps and arches in the tunnel that are prone to gas accumulation. For these locations, gas inspection must be carried out well.

(2) In the construction management of the tunnel face, it is necessary to ensure that survey is carried out before the excavation, fully grasp the actual conditions of coal seams and gases, and predict dangerous and unexpected situations^[3].

(3) Strictly strengthen the management of blasting, ensure the quality of electric

(4) detonators and explosives, control the total delay within 130 milliseconds, and ensure that the

blastholes are sealed in compliance with relevant regulations. Before blasting, all personnel should be evacuated from the tunnel, and the distance between the detonation point and both sides of the tunnel opening should be controlled at more than 30m.

(5) During tunnel construction, open-flames should be prohibited, and construction

personnel are strictly prohibited from carrying ignition supplies or tobacco into the tunnel. The use of open-flames should also be strictly prohibited within 20m of the tunnel openings.

(6) During construction, personnel should be strictly prohibited from wearing chemical fiber clothing when entering the tunnel.

(7) All personnel entering the tunnel should be equipped with safety protective

(8) equipment and be prepared with emergency rescue materials.

(9) During the construction, there must be assigned personnel on duty at the tunnel

entrance to register and inspect all persons entering the tunnel. They are strictly prohibited from entering the tunnel with prohibited items, and irrelevant persons should be strictly prohibited from entering the tunnel. And in the process of handover, both parties must sign and approve.

(10) Communication equipment must be provided near every construction work surface in the tunnel.

(11) Gas inspectors, blasters and electricians should all have certificates to work.

5 Conclusion

In summary, in the specific construction of low-gas tunnels, good safety technical measures and safety management are the keys to ensuring construction safety. Therefore, in specific construction, coal companies and construction teams must strengthen the management of construction safety and apply reasonable safe construction techniques. In this way, it is possible to eliminate potential safety hazards as much as possible, and to ensure the construction quality and safety of low-gas tunnels. It can also provide a better basis for the development of the coal industry and the satisfaction of social needs.

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