Research on the Application Strategy of Comprehensive Geological Exploration Method in Tunnel Geological Survey

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Abstract: With the growth of traffic demand, there are more and more tunnel construction projects. The technology and quality of tunnel inspection are directly related to the reliability of the tunnel project, and accurate determination of geological conditions is of great significance to construction safety and construction progress estimation during the development of tunnel engineering. It is of great significance to design tunnels in areas with high and steep mountains, rock formations, vertical and horizontal gullies, topography and landforms, which are often difficult to construct, with high technical standards and complex geological structures. Therefore, a reasonable exploration method is necessary. This paper focuses on the characteristics and main contents of geological exploration methods, and reveals the specific application of various methods in geological exploration in the process of tunnel exploration, hoping to provide some references for tunnel construction and exploration.

Keywords: Comprehensive Geological Exploration Method; Tunnel Geological Survey; Application Strategy; Research

1. Overview of Geological Exploration Methods

Geological exploration is carried out on the basis of comprehensive exploration methods, geological surveying and mapping methods, and drilling methods. The specific application of the comprehensive geological survey method should be determined according to the basic geological conditions of the study area. We need to determine basic data such as natural geographical environment, layered structure, topography and hydrogeological conditions, and select effective exploration methods for the harsh geological environment of the tunnel area, including soft soil, stone piles, sedimentary rocks, groundwater, rock formations, etc. At the same time, we should also combine the specific construction conditions and pay attention to the safety of the comprehensive geological survey method in the process of tunnel geological survey.

Comprehensive geophysical exploration technology requires less site conditions, quick action and light equipment. However, due to various factors, it is often difficult to ensure the accuracy of the test. Geological surveying and mapping technology have been widely used in the process of tunnel exploration. Comprehensively and systematically study the topography and geological environment of the tunnel area, study the stratigraphic hydrological conditions of the site location, and provide an effective reference for tunnel construction. Drilling technology is a relatively direct detection technology, mainly used to determine the hydrogeological characteristics of the tunnel area, and to further verify the results in combination with geological research. Drilling is carried out by direct coring method, which accurately reflects the geological and lithological characteristics of the site, and the basic physical and mechanical properties of the rock are obtained through experiments. However, the application of the drilling method is usually limited to accurately reflecting the geological and lithological characteristics of the site. This method is limited by the survey site and the long exploration period, and there will be some risks when mining special strata.

2. Geological survey of tunnel area

2.1 Topography and landforms

A tunnel is located on an important traffic artery in the northwest of a province in southwest China. The entire tunnel must be built on high mountains and ridges, arranged along the cliffs and at the intersections. The mountain moves from east to west, and the south is dominated by rocks, including mountains, lowlands, and forests.

2.2 Geological Formation

A detailed analysis of the geological structure in this area shows that the stratum in this area is obviously damaged and there are some fault zones. The tunnel entrance must pass through an inverted fault, and debris and breccias from extrusion, crushing and grinding can be found in the area. The fault runs from south to east. Due to the certain influence of the regional structure in this area, the lithological integrity is poor, and the cracks in the rock mass are very obvious.

2.3 Hydrogeology

The groundwater in the area where the tunnel is located is mainly carbonate karst water and Quaternary loose layer pore water. Mainly pipe water, in the form of a network, with a wide range of water supply and a long longitudinal extension.

3. Application strategy of comprehensive geological exploration method in tunnel geological survey

In order to analyze the hydrogeological conditions, engineering geological features and some unfavorable geological phenomena in the tunnel area, determine the surrounding rock grade, further assist in the design and construction, and provide better geological data. Combined with economic conditions, rational decision-making and comprehensive exploration are made through geological drilling, acoustic testing, and seismic exploration.

3.1 Engineering Geology Mapping

The unfavorable geological conditions are particularly prominent in the area where the tunnel is located. In addition, due to the criss-crossing trenches, mountain slopes and hidden variation, in the exploration process, the 1:2000 and 1:10000 geological maps need to be completed by the tracking method and the line crossing method, respectively. Compared with the traditional method, the control method for the poor geological conditions of the entire geological unit and the tunnel area is improved. This method breaks through the limitation of the mapping range and makes the mapping content more comprehensive and accurate. When drawing this map, the geological conditions of the Permian to Cambrian strata in the tunnel area were analyzed, and it was found that the unfavorable geology mainly included natural gas, groundwater and soft soil, especially the karst water developed in the tunnel. Extensive tracing revealed that on the geological path, it was blocked by another fracture that formed a lava source. Pipe laying directly affects tunnel construction: On the one hand, the tunnel may be flooded; However, in the process of tunnel construction, water can be reduced or interrupted, and there are problems with the domestic water supply of downstream residents. Therefore, we should pay attention to choosing the construction path to lay a solid foundation for future maintenance management.

3.2 Geological drilling

In the course of tunnel construction, great changes have taken place in rocks and many strata. During the exploration,

17 boreholes were installed, each located at 250 meters. Basically, each layer will be equipped with drilled holes. During drilling, diamonds or alloys are often used for drilling, such as breaking certain rocks in coal measure rocks, and drilling without backwater circulation. From the perspective of drilling depth, in addition to some special holes, it is also necessary to design a lower 2 to 3 meters high position in the depth of the tunnel. As for the sampling intensity, it must be ensured that the selected fractured layer and strongly weathered layer are controlled at more than 50%, the overburden rock should account for more than half of the total rock, and the groundwater must be carefully measured and recorded during each drilling process. In addition, the individual drilling speed of groundwater, the stratification of rock formations, and the color of the water should be recorded. The quality of the hydrostatic test data is further improved through the drilling method that intuitively characterizes the integrity and lithology of the sedimentary rock in the cavern. In the aspects of classification, segmentation, monitoring and evaluation, the coal seam was subjected to pumping test, acoustic wave test and gas test, and the sedimentary rock in the tunnel was quantitatively evaluated.

3.3 EH4

EH4 is a magnetotelluric measurement system that integrates natural and artificial field sources and uses a digital processor to obtain continuous conductance images. The actual detection depth ranges from tens of meters to 3000 meters, and its core is passive electromagnetic method. The system can utilize geomagnetic signals from natural sources and electromagnetic signals from artificial field sources. The detection depth of the artificial signal source is not high and can be used for the determination of the surface structure. Deep Structure reveals deep structure through natural background source images. The EH4 line has a fast layout speed and a high detection depth, which can accurately and clearly detect the buried depth and landform of the foundation. If the resistivity is inconsistent with the resistivity of the upper layer, EH4 has high precision and is widely used in tunnel exploration.

3.4 High density resistivity method

When processing geological exploration data with high-density electrical methods, it is usually necessary to input data from multiple processing terminals for further processing of raw data, such as soil correction, defect repair, format conversion, etc. Further, relevant software is used to determine the geological resistivity horizontal line in the study area, the formation resistivity characteristics are used to explain the formation structure, and the research results are drawn to lay a solid foundation for the follow-up work of the tunnel.

3.5 Seismic exploration, borehole ultrasonic logging and rock velocity testing

Due to the rapid development of recessive fractures in the tunnel construction area, many strata, strong surface weathering force and low drilling permeability, the core is mainly a blocky, broken and sandy material. When geologists evaluate rock weathering, it is difficult to objectively judge the quality of bedrock, and think that they have many human factors, and tunnel sedimentary rocks cannot be reasonably classified. Therefore, ultrasonic drilling methods, geological surveys, rock wave velocity tests, etc. are especially applied in the detection process.

4. Application of survey results

In the process of tunnel geological investigation, it took up to 3 months. Specific analysis of the hydrogeological conditions, structural fracture zone characteristics and unfavorable geological phenomena in the tunnel excavation area is of great help to the classification of surrounding rocks and gas analysis. During the exploration process, the type of surrounding

rock and water consumption of the tunnel were consistent with the actual situation, indicating that the tunnel construction decision in this area was correct.

In a word, correctly and scientifically measuring the tunnel before the start of the tunnel project is a necessary condition for the effective development of the tunnel project and the guarantee of the project quality. This tunnel is large, multi-layered, and has a long construction period, which requires systematic scientific research. According to the geological characteristics, the comprehensive geological exploration method of the whole area is adopted to scientifically classify the rock layers and clarify the rock stability, so as to provide effective guidance for the success of the follow-up work.

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