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Analysis of the Effective Application of Comprehensive Geophysical Exploration Technique in Tunnel Investigation

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Abstract: In the context of the continuous enhancement of social economy and scientific and technological development in my country, the scale of highway construction continues to expand. Among them, tunnels have the advantages of shortening highway mileage, optimizing linearity, and providing safety factors. The importance of tunnel construction in national highway construction is increasing day by day. In order to ensure the safety of tunnel construction and save construction costs, it is very important to do a good job of tunnel geological survey. As an important means of tunnel investigation, geophysical exploration is becoming more and more important and important in the investigation. In order to improve the accuracy of the survey level, it is necessary to take the reasonable application of the comprehensive survey method. Therefore, it is of great research and application value to carry out research on the application of comprehensive geophysical methods in the exploration stage to provide a scientific basis for subsequent tunnel construction.

Keywords: Comprehensive Geophysical Exploration Technique; Tunnel Investigation; Application Strategy; Research

1. Analysis of application significance of comprehensive geophysical exploration technique in tunnel engineering investigation

1.1 Ensuring the Accuracy of Tunnel Engineering Investigation

Geophysical exploration technology is based on the difference of the geophysical field of the detection object, and various factors such as related geological, ecological, boundary factors will affect the accuracy of the geophysical prospecting results to varying degrees. Compared with other projects, tunnel construction is more difficult to survey, and the accuracy of survey results is more important to tunnel construction and operation. Traditional geological survey analysis and drilling methods have problems such as low accuracy and blind spots between boreholes. Using geophysical methods to assist verification and comprehensive analysis is an important means to improve the accuracy of surveys. A single geophysical method is limited by the technology of the method itself, and all geophysical methods have uncertain and multi-solution problems. Therefore, the use of comprehensive geophysical exploration technology is an important and applicable way to further improve the integrity and accuracy of tunnel engineering survey results.

1.2 Ensuring the Efficiency of Tunnel Engineering Investigations

With the rapid development of engineering construction in my country, the efficiency of providing surveys is a requirement of engineering construction timeliness, and it is also a survey unit's need to control costs and provide guaranteed benefits. At the same time, my country's special geographical and geological environment features, a large number of high mountains, complex terrain and various adverse geological conditions also increase the difficulty of the survey. With

traditional drilling methods, in addition to the low density of drilling points and low accuracy, the difficulty of drilling in complex areas leads to long time and low efficiency, which is also a big problem, and the cost is also very expensive. Therefore, on the basis of analyzing the results of the on-site investigation, combined with some drilling holes, the use of comprehensive geophysical exploration technology is an important means and necessary measure to improve the efficiency of the investigation and reduce the cost on the basis of ensuring accurate determination.

2. The specific application of comprehensive geophysical exploration technology

At the current stage of tunnel exploration, there are various geophysical techniques. In order to give full play to the advantages and functions of various exploration methods, it is necessary to conduct a comprehensive analysis according to the local conditions, the purpose to be achieved by such exploration, and the specific local conditions, and select appropriate geophysical methods to carry out geological exploration. If the on-site conditions are inconsistent with the selected geophysical methods and basic needs, or the pertinence is not strong, it is difficult to ensure the integrity and accuracy of the intelligence results even if the geophysical exploration technology used is perfect. Therefore, it is of great significance to analyze the basic principles, advantages and disadvantages and application scope of various geophysical methods to reasonably combine and use comprehensive geophysical methods to ensure the accuracy and integrity of the results.

2.1 Tunnel investigation application of shallow surface seismic exploration method

The seismic exploration of the shallow surface does not need to be sampled in advance, and will not endanger the continuity of the rock mass. This method can directly determine the engineering geological conditions of the shallow structures such as the soil layer and the shallow strongly weathered layer. In recent years, many geophysical methods such as seismic exploration have been widely used, among which the refraction wave method and the reflection method are the main ones. These two methods can carry out all-round exploration operations. The basic principle of the refraction seismic method is: Seismic waves are emitted from the seismic source and hit a certain horizontal limit at various angles of incidence. During propagation, the wave velocity encountered by the seismic wave in the lower layer is greater than that in the upper layer of the elastic interface. When the incident angle reaches the critical angle (making the transmission angle 90°), it will slide on the interface and cause the particle to vibrate back to the ground at the upper layer of the interface. It is a refracted wave, and the interface parameters and other geologically relevant parameters. The working principle of reflected waves is based on the difference in seismic wave velocity between different rock layers, that is, between the overburden and the bedrock, and there are obvious differences. During the propagation of seismic waves in the formation, different reflected waves are generated by crossing the impedance boundaries of different waves, which are reflected to the surface. We use analysis of the reflected wave data to infer information about the overlay and other apparently reflective interfaces in the shallows. Through the analysis of the reflected wave signal, it can explain the changes of the overburden, the rock formation, the fault fracture zone, etc., thus the function of the road geological survey.

2.2 Application of soil radon concentration detection method in geological investigation

The basic principle is that if there is a significant fracture zone in the rock, radon gas will form, leading to a significant increase in the radon gas concentration in the surrounding soil. Through the measurement of radon gas concentration, the cracking state of the whole rock can be accurately grasped and judged. During the detection work, the detected soil radon gas

concentration data is closely combined with the drilling results to comprehensively analyze and judge, and use this method to draw the final result map of geophysical prospecting and infer the survey results. If the concentration in some areas is too high in the detection of the survey, it is necessary to carry out research and analysis on the principle of its occurrence.

2.3 Tunnel survey application of high-density electrical method

The working principle of the high-density electrical method is to use the Host, multi-level circuit converters and electrodes to collect data. After collecting data and information, and then using professional software, the resistivity map and contour map of the exploration area are finally obtained, and then the corresponding engineering geological and hydrogeological conditions are inferred. The density of measuring points and the total amount of electrodes in the high-density resistivity method are higher than those in the conventional resistivity method. The type of test points and the arrangement of electrodes should be efficiently converted according to the specific conditions of the project to ensure that the data information can be accurately processed. After one-time installation of electrodes, the survey operation can be ended, effectively preventing the phenomenon of mutual influence caused by excessive electrode installation, and obtaining relevant information through various electrode arrangement methods to ensure the accuracy of electrode arrangement. The high-density resistivity method can also use two-dimensional data acquisition to obtain three-dimensional survey results, and then improve the resolution through detailed division of the resistivity of the subsurface.

The high-density resistance method has the characteristics of high efficiency and low cost, and the result image is intuitive and convenient in time. And after years of use, it has high accuracy, especially for the abnormal water-rich geological structure near the tunnel. It is a common survey method in the tunnel survey stage, especially for some water-rich faults and water-rich karst detection.

3. Drilling for Tunnel Survey Applications

In the process of tunnel investigation, although the drilling method has certain limitations, it is still the most important and most intuitive and accurate investigation method at present. Drilling is the use of drilling rig equipment. The operation of the equipment can drive the drill pipe and the drill bit to run downward, drill holes of various diameters and depths, and obtain various geological data information to achieve the purpose of geological sample collection and academic research. Using this method, the core can be directly drilled, and qualitative geological data information can be obtained, so that the weathering level and color of the rock mass can be significantly reflected. The thickness of stratigraphic rocks can be clearly distinguished, so as to obtain data information such as fault characteristics and karst growth level. According to the relevant regulations and requirements of tunnel engineering geological exploration, it is necessary to closely combine comprehensive geophysical exploration and interpretation to carry out drilling and exploration of core lithological sections and geophysical abnormal zones, conduct geotechnical experiments and in-hole acoustic wave monitoring and other operations. This effectively understands and masters the geological conditions of each lithological zone of the construction project. Drilling is a direct survey method, and the geological information near the borehole is accurate, which is the supporting basic data in the survey, and is also an important data for the verification and comprehensive analysis of other geophysical methods.

All in all, at this stage, my country's public transportation industry is developing continuously, and the transportation network is becoming more and more developed. In the construction of various types of public transport network, tunnel construction is increasingly showing its uniqueness and importance. In the process of tunnel construction, carrying out effective and accurate geological survey is of great significance to ensure the safety of tunnel construction, save the cost of tunnel construction and shorten the construction period of the tunnel. In order to improve the accuracy and timeliness of the survey, reduce the cost of the survey and improve the benefit of the survey unit under the premise of ensuring the accuracy, it is very important to adopt the effective comprehensive geophysical prospecting method for tunnel survey, and its corresponding application is more and more extensive.

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