

Application Strategy of Integrated Geophysical Prospecting in the Treatment of a Tunnel Disease

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Abstract: China is a country with complex terrain and complex geological conditions. With the development of economy and society, the demand for transportation is also increasing. There are many railways on the mountainous areas. Geological diseases severely affect the construction quality and safe operation of the tunnel, causing huge economic losses. This paper introduces the principles and application strategies of these technologies.

Keywords: Integrated geophysical prospecting; Tunnel; Disease treatment

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1 Introduction

With the development of economy and society, people's demand for transportation is increasing. Many roads and railways have been built one after another, and terrain restrictions have gradually disappeared. More and more bridges and tunnels have been built and their scale continues to expand. In areas with complex topography and geological structure, some tunnels have poor geological engineering conditions. The excavation work created a series of loose areas in the rocks surrounding the upper part of the tunnel, which destroyed the local geological structure of the surrounding rocks and the circulation of groundwater, resulting in geological diseases such as collapse, mud gushing, lateral displacement of the tunnel and mountain cracks. There are geological diseases such as landslides in the tunnel. The construction or operation process has

a significant impact on construction time, operational safety and economic benefits of the tunnel^[1]. Currently, electromagnetic CT has been widely used in geological prospecting projects at home and abroad, with mature theories and rich practical experience. The borehole TV technology can record, replay and process image information completely and genuinely, and provide real-time geological data from multiple angles. In order to effectively manage tunnel diseases, it is necessary to use tunnel disease diagnosis technology to determine the cause and extent of the disease, and to analyze and evaluate the impact of lipid diseases on tunnel safety.

2 Basic Principles and Application Characteristics of Geophysical Prospecting Methods

Geophysical methods can be divided into seismic methods, gravity methods, magnetic methods, electrical methods, electromagnetic methods and radioactive methods. Different geophysical field studies adopt different methods. This paper uses high-density electrical methods and ground-penetrating radar methods to detect diseases in railroad tracks and tunnels. Both methods are based on the study of artificially excited electric and electromagnetic fields, which can deduce the electrical and elastic distribution of underground media.

2.1 High-density Electrical Method

The high-density electrical resistance method is a traditional direct current method, which is determined based on the electrical conductivity difference between different rocks (ores). The ground electrode is used to establish an artificial electric field underground, and electrical measuring instruments

observe the surface electric field changes caused by other conductive geological bodies to deduce and explain the distribution or occurrence of underground geological bodies (such as mud, faults, etc.). It is used to solve geological problems. The purpose of the question. The high-density resistivity method is also called electrical resistivity tomography. This is a geological tomography technology that combines electrical profiling and electrical prospecting features. High-density sampling is used to increase the sampling rate, and the "multiple coverage" method is used to increase the signal-to-noise ratio. This is a high-precision direct current method that can intuitively reflect the spatial characteristics of underground geological bodies^[2].

2.2 Ground-Penetrating Radar Method

GPR (Ground-Penetrating Radar) is an electromagnetic induction method. Natural and artificial electromagnetic waves have a very wide electromagnetic spectrum. Electromagnetic wave detection is a very important field in geophysics. Both artificial and natural field sources are used. In terms of frequency range, the MT method uses natural field as the field source, which has the lowest frequency and large detection depth. Microwave remote sensing or optical remote sensing has high resolution, but the sensing depth is very shallow^[3].

3 Application Strategies of Geophysical Prospecting Methods

3.1 Application Strategy of High-density Electrical Method

The high-density electrical resistance method data acquisition system includes a profile observation system and an electrical prospecting observation system. The electrical profiling method is used to plot the vertical electrical interface, and the electrical prospecting method is mainly used to plot the horizontal electrical interface. Therefore, the high-density electrical method has high observation data accuracy and abundant geotechnical engineering data, shows good results in the investigation of uneven underground electrical bodies, and has good application prospects in geological exploration engineering.

3.1.1 Equipment Selection

The high-density electrical resistance method uses

a three-potential electrode system. By changing the wiring method of the four electrodes, the apparent resistance values of the three components can be obtained. These electrode arrays can be used individually or in combination as required. Generally, in high-density electrical measurement, the greater the electrode distance a or the greater the insulation coefficient n , the greater the detection depth. The smaller the electrode distance a or the smaller the insulation coefficient n , the higher the horizontal resolution. However, due to the limited resolution of these devices, high-resolution images may not be generated. You can use multiple devices in profile measurement, but not too many. One reason of this is to avoid increasing the acquisition time, and the other is to avoid increasing the analysis workload and confusion^[4].

3.1.2 Things to Note

Combined with actual prospecting experience, several issues should be considered in the field data collection of high-density electrical methods. According to the objects to be detected (detection depth and accuracy requirements), choosing the appropriate electrode spacing is related to the quality of the collected data, and sometimes on-site testing is required. Determine the best magnetic pole distance. Before collecting official data, it is very important to check the ground resistance of each electrode. By checking and rearranging the electrodes, the defects in the collected data can be greatly reduced if each electrode has good grounding effect. High-density electrical methods are sometimes interfered by electromagnetic sources in the environment. During the measurement, the data changes should be observed simultaneously. If the trip point changes too much, please check for the interference and observe again. Choose suitable measuring equipment's and use two or more instruments to measure the same measuring line to ensure the reliability of the collected data. When the high-density electrical resistance method is used for measurement, large currents flow into the ground, so people and animals should not be in contact with the electrodes.

3.1.3 Data Processing

The high-density raw data collected on-site must be formatted and then processed by software. The main processing includes data pre-processing, forward calculation and inverse calculation, and finally

obtains the apparent electrical resistivity curve. The purpose of data pre-processing is to improve data quality, eliminate interference caused by factors such as grounding conditions, terrain factors, and electrical unevenness, and improve data readability. The purpose of forward calculation is to obtain a stable current field and the potential value of each measurement point, while the purpose of inversion is to obtain the spatial distribution of apparent underground resistance to characterize the distribution of underground electrical characteristics.

3.2 Application Strategies of Ground-Penetrating Radar

Ground-penetrating radar (GPR) uses electromagnetic radiation to detect underground media. The propagation of electromagnetic waves in the medium is similar to seismic waves, and the law of motion is similar to seismic prospecting. Therefore, most seismic information collection, processing and analysis methods and technologies can be used as references for ground-penetrating radar.

3.2.1 Selecting Measurement Methods

There are two measurement methods for ground-penetrating radar. One is the reflection measurement and the other is the refraction measurement. Reflection measurement is a commonly used method in profiling. The profiling method is a fixed-distance measurement method in which the transmitting and receiving antennas move synchronously along the measurement line. According to the various movement modes of ground-penetrating radar data acquisition, it can be divided into continuous measurement mode, discrete measurement mode (point measurement) and wheel measurement mode.

3.2.2 Data Processing

For data collected on site, a series of data processing is required before interpretation. Raw data contains not only useful information, but also various kinds of noises. The purpose of data processing is to minimize the noises and improve the signal-to-noise ratio so that the ground-penetrating radar data can be accurately interpreted.

3.2.3 Interference Recognition Technology

The ground penetrating radar system is an ultra-wideband radar system. There are various types of communication signals in the working frequency band: TV, broadcasting, mobile communication,

satellite communication. Roadbed and tunnel inspections detected many sources of electromagnetic interference. Some of these interference sources have strong energy and can even completely cloak underground radar echoes. It is necessary to analyze these interferences. On the one hand, the impacts of such interference should be avoided or reduced during the data collection process. On the other hand, interference information must be accurately identified in data interpretation.

4 Conclusions

Combining the research and analysis of the principles and techniques of various geophysical prospecting methods with actual work, we came to the following conclusions: the high-density resistivity method is a method that combines the resistivity detection method and the resistivity profiling method, it has high data collection efficiency and high reverse automation. The resistivity curve obtained can directly reflect the distribution of underground electrical characteristics, and can better differentiate the electrical layers. It can directly reflect the spatial location and morphological characteristics of underground karst, fractures and aquifers. Compared with the other two methods, the high-density electrical method is more intuitive, more accurately reflects the overall electrical characteristics of the measurement area, and has the strongest anti-interference ability, but it is affected by terrain and ground conditions. The ground penetrating radar method is flexible, adaptable, has high horizontal and vertical resolution, and can identify small abnormalities. Compared with the other two methods, ground-launched radar has the highest resolution and can solve engineering detection problems with different accuracy requirements, but it is susceptible to environmental electromagnetic interference. In the work of ground penetrating radar (GPR), electromagnetic interference sources in the environment should be removed as much as possible. If the interference cannot be eliminated, the nature and location of the interfering object should be recorded in time to provide reference for future data processing and interpretation.

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