Research on slope investigation using high density resistivity method

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Abstract. In this paper, high-density resistivity of the north bank of Huangming Reservoir in Yuyao City was detected by the Wenner device. Through the detection of multiple sections in the longitudinal and transverse sections, the distribution rules of the rock mass of the slope are summarized, and the weathering grade of the rock is judged. The research results will provide a strong basis for the disaster prevention and mitigation work in the later period.

1. Introduction

High-density resistivity method, also called Resistivity Tomography, is a geoscience tomography technology that combines the characteristics of current collecting profile and electrical sounding. This method is used to survey high slope[1], rock slope stability[2] and slope rock mass fracture development exploration[3].

In this paper, the Wenner device is used to physically detect a slope in Yuyao area to analysis the stability of the slope and the weathering degree of the rock mass. The results will provide the basis for disaster prevention and mitigation work.

2. Engineering situation

The research slope is located on the north bank of Huangming Reservoir in Yuyao City. The geographical position is east longitude: 121°07′25.90″, north latitude: 29°55′47.96″. Most of the excavation slopes in the exploration area are rocky slopes, and the slope foot is important access routes for the villagers. At present, the slope rock mass is bare and easy to weather. It will pose a greater threat to the life and property of pedestrians on the slopes once the weathered rock mass collapses, landslides and other geological disasters.

3. Slope physical detection

3.1 Investigation technique

This survey used the Wenner observation device. The Wenner observation device is the symmetrical quadrupole resistivity measuring device. A, B as the power supply electrode, M, N as the measuring electrode, AM = MN = NB as a electrode interval. Through a symmetric arrangement of equal electrode spacing, the DC electric field theory and the uniform underground half-space electric

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field distribution law are used to study the resistivity variation law of a certain layer depth. With the gradual increase of the spacing factor n, the electrode spacing is evenly opened, and the depth of detection increases with the depth of the layer increases. Finally, the computer automatically draws a cross-sectional color map with an inverted trapezoid. The field measuring instrument equipment uses the DUK--2A high-density electric measuring system developed by Chongqing Geological Instrument Factory of China National Equipment Group. The main parameters are: minimum spacing factor is 1, maximum spacing factor is 16, point spacing is 3m, one array consisting of 60 electrodes, section length is 177m, working voltage is 180 ~ 270V.

3.2 Measuring circuit scheme

Using the 1:1000 topographic map as the basic hand map, 8 lines are pre-arranged on the topographic map, which are 1-1'-8-8' lines. The 1-1'-3-3' and 7-7'-8-8' lines are basically along the main axis of the slope (i.e., the direction of the basic vertical contour). The 4-4'-6-6' line is vertical. The direction of the main axis of the slope (that is, the direction of the substantially parallel contour) is shown in Figure 1. Quaternary (full weathering layer), the apparent resistivity (ρs) < 1000Ω.m; bedrock, the apparent resistivity (ρs) > 800Ω.m; bedrock fracture or fracture joint development, the apparent resistivity (ρs) < 1000Ω.m.

4. Data analysis of physical detection.

4.1 Abnormal inference basis for physical detection

The apparent resistivity curve has a uniform ribbon and a slow change, reflecting that the subsurface medium is relatively uniform or continuous. If it is high-resistance, the lithology is relatively complete. If it is relatively low-resistance, it indicates that the bedrock weathering layer has a certain thickness. If there is a disordered, isolated relatively low-resistance anomaly or an apparent gradient of apparent resistivity in a high-resistance, uniformly-changing apparent resistivity curve, the lithology is more fractured or developed. The relatively high and low resistance anomalies in the shallow part are generally caused by the cover layer.

4.2 Results and analysis

The results of the apparent resistivity value using high density resistivity method of section 2-2', 5-5' are researched in this paper.

(1) The apparent resistivity section diagram of section 2-2'
According to Fig.2, the apparent resistivity section diagram of section 2-2’ is messy, and the apparent resistivity value on both sides of the section is bigger than intermediate section. Apparent resistivity value fluctuation range is large, between 334 and 1000Ω.m

In the section of the line surface, the length of the surface is about 40/2~120/2, and the apparent resistivity is relatively low. It is speculated that this section is a dense zone of joint fissures. The length of the section is 153.4m, the thickness of the quaternary system (including the fully weathered layer) is 0.6-2.6m, ρs<1000Ω.m or disorder; the high-middle weathering layer ρs>1000Ω.m. In the line length of 40/2 ~ 100/2, between 2.0 ~ 40m below the surface, the apparent resistivity is relatively low, it is speculated that this section is a joint fissure dense belt.

![Figure 2. The 2-2’ survey line sectional drawing of apparent resistivity value using high density resistivity method](image)

(2) The apparent resistivity section diagram of section 5-5’

As shown in Fig. 3, the apparent resistivity value of the surface of the line is relatively disordered. On the whole, the value on both sides are relatively higher than the middle value. The apparent resistivity value fluctuation range is large, between 345 and 7561Ω.m. In the section of the survey surface, the mileage is about 50/5~130/5, the apparent resistivity value is relatively messy, and the three regions have relatively low apparent resistivity values. The Quaternary (including the fully weathered layer) is 0.1-2.5 m thick, ρs <1000Ω.m or disorder; the high-middle weathering layer ρs>1000Ω.m. The apparent resistivity is relatively lower between 1.0~50m below the surface in the range of 42/5~130/5 of the line. It is speculated that the three regions are the joint fissure dense zone.

![Fig. 3 The 5-5’ survey line sectional drawing of apparent resistivity value using high density resistivity method](image)
5. Conclusions

Two results are obtained through the physical detection:

(1) The thicknesses of quaternary cover (including completely weathering layer) fluctuate obviously. Thickness between 0.0-4.1m. The bedrock is relatively broken and the fracture is relatively developed.

(2) The apparent resistivity values are lower in the detection slope. The apparent resistivity values are higher on both sides. The direction of the joint surface are consistent with sliding surface, and have the possibility of sliding.

It is recommended to detailed survey with geological drilling, so as to remove hidden trouble.

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