

Application of Common Geophysical Prospecting Techniques in Pile Foundation Testing

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Abstract: Pile foundation is the main transfer carrier of the upper load of bridge and roadbed, which is mainly composed of concrete, water, additives, sand aggregate. As the pile foundation needs to bear a large external load in the process of operation, there are many risk factors such as segregation, adding mud, reducing diameter and fracture of the pile body. Therefore, this paper takes geophysical detection technology as the starting point, and analyzes the application principle and measures of geophysical technology in pile foundation detection.

1. Introduction

The continuous development of testing technology provides a good opportunity for the development of sophisticated instruments. In particular, the application of pile testing instruments has promoted mutual benefits among geophysical exploration methods, geotechnical engineering, loosening engineering and geotechnical engineering, laying a solid foundation for the development of pile foundation in geophysical exploration and testing technology. In order to ensure the accuracy of test results, it is of great significance to analyze the common geophysical exploration techniques of pile foundation in the current testing process.

2. Overview of geophysical exploration technology

Geophysical exploration technology mainly based on geophysical theory and physical characteristics such as density, radioactivity, magnetism and elasticity among rocks, to analyze the changes of geophysical field in the engineering area with reasonable detection instruments and methods. Further, the water level geology and conditions in the project area are obtained ^[1].

3. Application principle of geophysical prospecting technology commonly used in pile foundation testing

3.1 Application principle of cross-hole ultrasonic fluoroscopy method

According to the relevant requirements of JGJ1062014, "Technical Regulations for Building Pile Testing", the cross-hole ultrasonic wave mainly uses mechanical waves with a frequency of 20.0 kHz. Acoustic wave transduction is performed in a low-frequency ultrasonic monitoring instrument capable of displaying a wavefront to obtain a medium sound velocity, a dominant frequency, and an amplitude. Then analyze and determine the internal structure of the medium ^[2].

3.2 Application principle of high and low strain method

The high strain method mainly uses the method of impacting the pile top by the heavy hammer, which result to a large displacement of the pile foundation-soil body, and stimulates the soil resistance around the pile body and the support force of the pile base end. The acceleration sensor is then mounted on both sides of the pile below the pile top. The acceleration sensor can be changed according to the stress wave signal when the weight is impacted. Combined with the stress wave theory analysis, the bearing capacity of the pile foundation can be determined and the integrity of the pile body can be evaluated.

The low strain method is mainly based on the distribution characteristics of stress waves in the

pile body. It is assumed that the pile is a continuous elastic one-dimensional homogeneous member, and vertical excitation is set at the top of the pile. The elastic wave is then caused to propagate down the pile gradually. If the pile body has a difference in wave impedance such as fracture, diameter reduction, and segregation, the elastic wave will reflect and project. After subsequent amplification processing, defect information at different positions can be determined.

3.3 Application principle of geological radar

The geological radar method mainly carries out the ultra-high frequency electromagnetic beam emission of 103 kHz-106 kHz in the form of wide frequency band and shot pulses through the transmitting antenna according to the difference of electrical properties of different underground media. If the electromagnetic wave encounters a medium difference such as a fracture surface in the propagation of the pile body, a reflected wave can be generated. And through the receiving antenna, feedback to the host. The pile body quality can be determined by analyzing the feedback time and wavefront of the reflected wave signal.

4. Application measures of geophysical exploration technology in pile foundation testing

4.1 Application of Cross-hole Ultrasonic Perspective in Pile Foundation Detection

In the process of pile foundation testing, ultrasonic wave velocity will change appropriately according to the change of concrete strength. Therefore, when the ultrasonic wave passes through the weak layer or defect part of pile foundation, it can directly penetrate or avoid shooting. That is, the time value of sound increases, amplitude and frequency decrease. According to this principle, the internal condition of pile foundation can be obtained.

During the actual pile foundation inspection operation, the tester can use the RSMSY7 digital intelligent acoustic wave detector to detect the concrete medium by using a 38 kHz single-shot single-column radial transducer. In the WYS2006 engineering geophysical information system, the three-dimensional inversion processing of the ultrasonic projection data is performed. Since the pile foundation is formed by a plurality of materials, the detector can perform the application of the low-energy transducer according to the pile-based medium in order to avoid large-area attenuation in the ultrasonic propagation. For example, in the process of detecting the parallel surface of the concrete pile foundation, the inspection personnel can perform surface cleaning and grinding operations on the position of the measuring point. At the same time, butter or petrolatum is used as a coupling agent, and sufficient water is injected into the parallel detection holes, and then the medium is detected.

Taking the ** bridge 15# pier 13# pile test as an example, the project is a circular cast-in-place pile with a designed pile diameter of 2800 mm and a designed concrete strength of C32. In the process of ** engineering pile foundation testing, the inspector can pre-bury 4 sound tubes inside the pile foundation and divide them into 6 test profiles. The test parameters are set to gain 10, low pass 45 kHz, high pass 4.5 kHz, sampling and the pulse width is 6 μ s and 28 μ s, respectively. At the same time, the distance between the measuring points is set to 0.18m Together with the field test sound velocity value, the wave velocity of the abnormal speed of the sound velocity can be obtained.

4.2 Application of high and low strain method in pile foundation detection

On one hand, the application process of the high strain method, first, the tester can select the precast pile whose strength is restored above the pile body and the basic recovery time after the pile sinking, or the cast pile with the clay soil above 28d. The pile cap is made after the detection target is determined. And set the detection intensity.

Secondly, the tester can select the DSZ3 automatic leveling instrument to observe the standard height of the pile top. And in the upper part of the yellow sand, pile padism. At the same time, symmetric installation of two acceleration sensors and strain sensors is performed at the position of the pile body at a distance of 2 times the pile diameter.

Finally, set the instrument to use the parameters to perform the hammering operation. The DSZ3 automatic leveling instrument is used to observe the top elevation of the pile. To perform the penetration calculation.

On the other hand, according to the relevant requirements of JGJ94-2008 of the Technical Specification for Building Piles, in the process of testing, the inspectors can first process the pile foundation. The slurry in the pile foundation will be removed until the concrete leaks out.

Secondly, the sensor is installed on the basis of keeping the concrete surface dry and flat. In the sensor installation stage, in order to ensure the sensitivity of the sensor, the inspector can use butter and plasticine to install the sensor on the pile base at a distance from the tapping point. It is generally $2/3$ radius or $1/2$ position from the center of the pile.

Finally, the constructor can start the sample equipment and use a force bar or a small hammer to hammer at the center of the pile foundation or at 90 degrees from the hollow pile and the sensor. According to the wavefront, the quality and grade of the pile foundation are determined.

Taking the B project as an example, the B project is a commercial house, and the pile type is 445mm*445mm concrete precast square pile, the concrete grade is C38, and the support layer is silty sand layer. In order to determine the stability of the pile foundation in the project, the pile foundation was tested by low strain method. In the test, the wavefront of the type I pile motion measurement is clear, and there is no obvious defect before the $3L/C$ time; the type II pile motion measurement has some micro-deformation, and there is a slight defect reflection plate at the time of $3L/C$, and the wave velocity is at a normal level.

4.3 Application of geological radar method in pile foundation detection

According to the relevant requirements of the Geophysical Exploration Procedures for Water Conservancy and Hydropower Engineering (SL326-2005), in the process of pile foundation testing, the inspectors can use the professional pulse of the Canadian pulse EKKO PRO, using a 500.0MHz shielded antenna at the selected antenna frequency. On the basis, the sampling rate is set to 0.45 ns, the antenna transmission and reception distance and the antenna step are 0.22 m and 0.01 m respectively, and the number of system superpositions is 62. At the same time, in order to avoid the influence of random interference and external interference on the acquisition speed and acquisition accuracy, the tester can according to the electromagnetic wave detection range propagation speed along with his own work experience, the electromagnetic wave detection speed is set to 0.11 m/ns.

Taking the A project as an example, the A project is an 11-story and a 1-story underground structure. The main building and the underground garage are all bored pile foundations. The uplift pile of the underground garage is in the form of a column and a pile. The pile foundation diameter is 660mm, and the effective pile length is between 28-31m. After the upper construction is completed, some beams and columns of the project have cracks, and this is obvious uplift deformation. The maximum drop is about 180mm. According to the characteristics and the above-mentioned geological radar detection equipment and methods, the pile foundation of the uplift pile can be tested^[3].

After the pile foundation testing is completed, the detection personnel can follow the output flow of original data editing and Dewow filtering analysis -- time zero setting and spectrum analysis -- filtering and attribute analysis -- gain and time-depth conversion -- profile, to filter the low-frequency oscillation and high-frequency noise in the signal and extract the instantaneous amplitude, frequency and phase. If the uplift pile is intact, the radar image features should be identical, which means that the lineup of pile medium reflected by radar wave is continuous operation mode. If there is a fracture on surface of the pile, the radar wave profile will show the break lineups and significant amplitude variation, as well as prominent image disorder and reflection attenuation. (See in Figure 1)

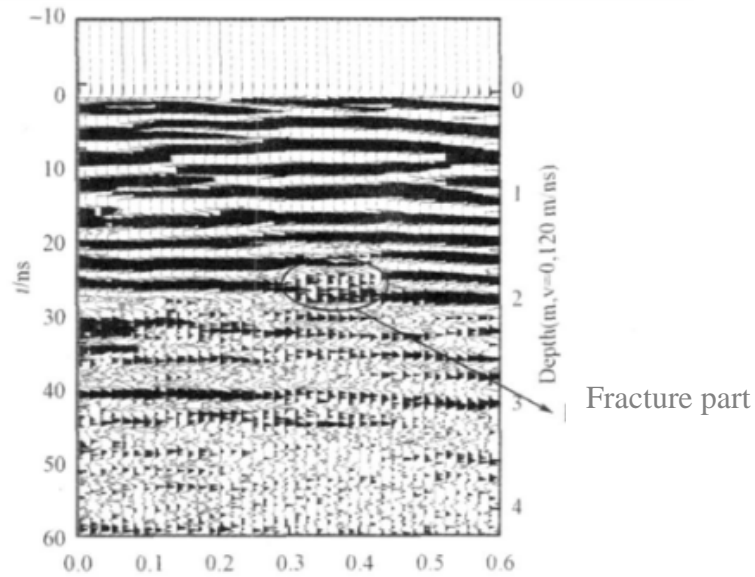


Figure 1 Geological radar image of the fractured pile

5. Conclusion

In conclusion, geophysical exploration technology has the advantages of high efficiency and low cost in pile foundation testing. Therefore, in the process of pile foundation testing, testing personnel can reasonably select such methods as cross-hole ultrasonic testing, high-low strain testing, and geological radar testing according to the internal medium of the testing pile, giving full play to the practical application value of geophysical exploration technology in the internal structure detection of pile foundation, which provides basis for the smooth construction of pile foundation.

References

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