



REVIEW

Exploration of Geotechnical Engineering Investigation under Complex Topographical and Geological Conditions

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ABSTRACT

This paper will explore the geotechnical engineering investigation technology under the complex topographical and geological conditions, and introduce how to construct the water supply tube wells faster and better under the complex topographical and geological conditions by taking Inner Mongolia as an example, so as to provide reference for the relevant professionals.

1. Introduction

From a map, we can see that the actual terrain of the Inner Mongolia Autonomous Region extends from east-west direction to south-west direction, showing long and narrow on the whole and most areas of the Inner Mongolia Autonomous Region are plateaus. As the Inner Mongolia Autonomous Region is dominated with the temperate continental climate and crosses the four major water systems i.e. the Yellow River, Ergun River, Nenjiang River and Xiliao River, the groundwater resources are rich there in general, but the surface water sources are low quality with small water yield, large change and more sediments and cannot satisfy the actual demand of residents of the Inner Mongolia for water completely. With the purpose to change the situation effectively, it is necessary to utilize groundwater resources fully. As water sup-

ply is the main way and means of extracting groundwater resources, how to conduct reasonable groundwater development under the complex topographic and geological conditions in Inner Mongolia will be a concern needing immediate solution by professionals.

2. Types and Distribution Features of Groundwater in Inner Mongolia

2.1 Daxinganling Region

The Daxinganling Region has the actual groundwater type of the bedrock fissure water mainly from volcanic rock, pyroclastic rock and metamorphic rock. The bedrock fissure water is dominated with phreatic water with the fissure weathering zone as the actual aquifer and the actual water content of groundwater directly depends on the development extent of fissures. However, in the Daxin-

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ganling Region, the whole bedrock fissure water presents the actual development direction from east to west and the closer to the west, the weaker the actual development of the fissure will be, thus resulting in the weakening of the actual aquifer thickness and water content of the fissure.

2.2 Xiliao River Plain Area

Xiliao River Plain Area of Inner Mongolia is a sedimentary basin formed since Mesozoic. The groundwater resources in this area can be classified into loose rock pore water and clastic rock pore water as the verticality. Thereof, the actual aquifer of loose rock pore water is widely distributed and its groundwater is thinner in basin edges and thicker in the center on the whole. The actual aquifer of clastic rock pore water is mainly distributed in the middle of Xiliao River Plain and the majority of the aquifer has such actual rock as glutenite, gritrock and middle- fine sandstone. Both types are high-quality and can act as the domestic water for residents.

2.3 Inner Mongolia Plateau Area

The Inner Mongolia Plateau Area is located in the north of Yinshan Mountain and the west of Daxinganling Mountain. It is mainly composed of mountain & hill area, basalt lava platform, Otindag desert area, high plain area and quaternary valley depression. As the actual geological environment of the whole area is relatively complex, the types and distribution of groundwater are also different. The groundwater in the mountain & hill area is mainly distributed around the northern national borderline and Suet-Xilinhot and mainly dominated with the fissure water from volcanic rock, metamorphic rock and granite, high quality on the whole; the groundwater in the basalt lava platform is mainly in the north of Xilingol and dominated with the fissure water from basalt, presenting gradually deeper groundwater level and larger water quantity from the third-level platform to the first-level platform on the whole; in the Otindag desert area^[1], the groundwater changes little in depth and dominated with the water from sandstone and glutenite on the whole, with the likelihood of overflow due to pressure bearing; the quaternary valley depression is the main water source of the whole Inner Mongolia and its internal groundwater is mainly surrounded by alluvial sand, alluvial proluvial sand and gravel layer; as the majority of groundwater aquifer is distributed around Hulun Buir and the depth is smaller, the residents can extract and use the groundwater easily.

2.4 Yinshan Mountain Area

The groundwater in Yinshan Area is dominated with fis-

sure water, mainly distributed around Jining-Fengzhen and mainly surrounded by ancient bedrock, high quality on the whole. But the groundwater resources in other places than Jining-Fengzhen belt are not very rich, so it is relatively more difficult for residents to extract water.

2.5 Hetao Plain Area

Generally speaking, the aquifer in Hetao area is mainly surrounded by middle-fine sand and middle-coarse sand. As Hetao area is closer to the Yellow River, the groundwater content in rock is relatively richer. In Hubao Plain area, the groundwater is mainly surrounded with alluvial rock and dominated with confined water, so it is likely for the water to flow over. In the Houtao Plain area, the aquifer is dominated with Pleistocene phreatic water in the upper part and Pleistocene confined water in the lower part^[2].

2.6 Ordos Plateau Area

In Ordos area, the groundwater is dominated with loose rock pore water and clastic rock pore water. Thereof, the former is one of the main sources for the residents in Ordos Plateau and widely distributed and the latter, which is dominated with Cretaceous phreatic water and confined water with thicker aquifer, larger content and high quality, is also frequently used by the residents in Ordos Plateau.

3 Relevant Technologies of Geotechnical Investigation

With the purpose to get the actual data and parameters of the rock-soil layer, analyze the actual distribution of groundwater in the investigation area through the data of the rock-soil layer and discover the groundwater resources ASAP, it is necessary for relevant workers to conduct actual investigation and exploration according to relevant geotechnical engineering standards. Due to the complex topographical and geological conditions of Inner Mongolia, several geotechnical investigation methods will be used for practical exploration. The geotechnical investigation technologies which are frequently used today will be briefly described as follows.

3.1 Geological Surveying and Mapping

Geological surveying and mapping is a step which shall be firstly improved in all geotechnical engineering investigation processes. The main role of this step is to help relevant workers to analyze and learn the investigation area in a more scientific and clearer way. After completing the geological surveying and mapping, the relevant workers can have preliminary knowledge of the data in the topography

and geological structure in the investigation area so that relevant workers can preliminarily analyze and authenticate the topographic and geological data and characteristics of the area according to these data and preliminarily assess that whether this investigation area is rich of groundwater resources and worth of groundwater resource exploitation^[3].

3.2 Boring

Similar to geological surveying and mapping, the boring is also a very common technology in geotechnical investigation. In actual investigation, the boring technology is generally supported by certain bench drilling machines for actual boring and investigation on the rock-soil layer of the investigation area. With the purpose to improve the effect of boring, relevant workers usually conduct actual boring by convoluted drilling and mud-off^[4]. During boring, if any clayed soil is discovered in the rock-soil layer in the investigation area, relevant workers shall keep the extraction rate of the geotechnical core over 90%. Therefore, with the purpose to discover the actual characteristics of the rock-soil layer, relevant workers shall have high expertise so as to guarantee the actual boring effect of the boring technology and provide important investigation indicators for future investigation assessment.

3.3 In-situ Test

In situ test is also a common testing technology during geotechnical engineering investigation. One of the important links of this technology is the static penetration experiment using penetration probe. With the purpose to guarantee the actual effect of static penetration in a better way, relevant workers shall use the original static penetration probe for static penetration experiment, and import the test data of the investigation areas fed back by the probe into a computer for analysis and processing^[5]. The other important link of in-situ test is the standard penetration test where the tester needs to test using standard drop hammer, clean bores before test and conduct standard penetration test as 30min per time. This test link can not only effectively figure out the basic physical properties of the investigation area, but also, as the most fundamental and effective test method in the whole in-situ test technology, analyze the relevant data required for geotechnical engineering investigation so as to provide data support for subsequent data analysis.

3.4 Interior Test

We shall conduct targeted interior test according to the investigation issues that relevant workers encounter during geotechnical engineering investigation and the actual

geological characteristics of the investigation area, find out the solutions according to the test results and obtain the scientific and accurate physical indicators and data. Generally speaking, during interior test, relevant workers need soil compressibility, soil layer properties determination and other soil information. Such information shall be figured out from field investigation by relevant workers in the investigation area. In combination with other aspects, the actual types of groundwater and concrete features of sandy oil can be finally determined for the subsequent groundwater exploitation^[6].

4. Key Points for Design of Water Supply Tube Well

4.1 Well Depth

As the groundwater resources are richer with lower depth and thicker aquifer in Inner Mongolia, the range of 100m-150m is decided after all aspects are considered.

4.2 Well Structure

With the purpose to effectively prevent the infiltration of groundwater during the construction of water supply tube well, in combination with the actual situation of the aquifers of different areas, the thickness of the well filter material shall be controlled within 75-150mm in general.

4.3 Casing Tube

The frequently-used casing tubes for water supply tube wells are made of steel or cast iron, which shall be decided according to the actual regional characteristics from the geotechnical engineering investigation. The casing tubes can also be made of cement in certain areas. The diameter of casing tubes mainly depends on the actual demand of the residents for water and the design pumpage. When the quantity of water required is small, the design diameter of casing tubes can be decreased properly and when it is big, the design diameter can be increased properly.

4.4 Filter

A filter is usually composed of the filter tubes as well as screens of different forms and the filter materials of different specifications. Thereof, the filter tubes are usually selected from bridge tubes and spiral tubes as concrete requirements. When a filter tube is processed, it shall be perforated at the rate of not lower than 30% according to the actual water requirement. The filter tube is buried in the acquirer, so it is necessary to conduct test and processing according to the actuality of the area. The filter materials are usually the gravel with certain level and the thickness

within 75-150mm. The concrete thickness shall be calculated according to the actual investigation data of the area^[7]. In terms of filter screens, the filter screens are not recommended in the rock-soil geology dominated with middle-coarse sand and middle-fine sand represented by Hetao Area of Inner Mongolia, because they may reduce the actual pore size of the filters, increase the water intake resistance and decrease the actual water discharge yield from water supply tube wells. If the rock-soil layer contains more silty sands or silty fine sands, it is necessary to use screens in this area, because they can effectively prevent sands/stones from entering the water supply tube wells and improving the well completion rate and well supply effect.

4.5 Water Stop and Well Seal

The actual work of water stop and well seal usually depend on the actual demand of residents for water. For example, for the water supply tube well for agricultural water, we shall only consider the seal of the mouth rather than do more for water stop on the water supply tube well. But if there is a bad aquifer or polluted stratum around, we shall complete geotechnical engineering investigation, and shall not conduct water stop and well seal until relevant problems are discovered. For example, for the tube well of portable water for residents, during the well completion, we usually use pure clay or clay ball for actual water stop of the water supply well in the areas without bad aquifers or polluted stratums. The well mouth can be sealed by concrete and the length of the mouth water stop band after water stop and well seal shall not be smaller than 5m^[8].

4.6 Well Flushing and Water Pumping Test

Both well flushing and water pumping test are important links during the actual construction of water supply tube well. In general, the well flushing will be conducted by the three methods i.e. piston, air compressor and immersible pump. If these methods don't generate good effect in flushing, relevant workers can use appropriate phosphate solution or CO₂ during flushing. The water pumping test is usually synchronous to the well flushing and is an important basis to determine whether the extraction equipment are suitable.

5. Conclusion

In light of the complex topographical and geological con-

ditions in Inner Mongolia, with the purpose to construct the water supply tube well in a better way in this area, we shall conduct complete geotechnical engineering investigation before tube well construction, then relevant personnel shall figure out the groundwater types and distribution features based on the rock-soil data from the geotechnical engineering investigation, distinguish the points richest of groundwater, and then we shall conduct actual boring as well as subsequent test and determine the actuality of the groundwater in the investigation area so as to provide strong data support for the construction of the water supply tube well in future, increase the completion rate as well as the service life of the water supply tube well, guarantee the water safety and quality for residents.

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