ISSN: 2414-1895 DOI: 10.6919/ICJE.202309_9(9).0025

Feasibility Analysis of Inclined Hole Drilling in Special Working Condition Exploration

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Abstract

Under some special engineering conditions, conventional drilling is difficult to meet the requirements of investigation or to carry out, which brings a lot of trouble to engineering investigation, it is necessary to study the feasibility of inclined hole drilling in special working condition investigation. It is found that it is feasible to apply inclined hole drilling technology to engineering investigation under special conditions, which can not only meet the requirements of investigation, but also improve drilling efficiency and reduce construction cost.

Keywords

Inclined Hole Drilling; Special Working Condition; Engineering Investigation; Feasibility Analysis.

1. Introduction

In recent years, with the development of engineering exploration technology, inclined hole drilling plays an irreplaceable role in some projects where it is difficult to meet the requirements of exploration by using conventional drilling methods. The slant hole drilling technology comes from horizontal directional drilling, which abandons the characteristic of "Straight up and straight down" in the traditional drilling method, but drills into the ground at a certain angle through the design of drilling hole location, the strata revealed by multi-angle drilling with same hole depth can be reduced from 3D level, and it is not affected by topography and surrounding environment, and has obvious advantages over traditional exploration [1,2].

2. Study of Special Working Conditions

2.1 Existing Road Engineering Survey

With the development of road traffic in our country, the geological conditions through which the route may pass are becoming more and more complex, and the engineering investigation is becoming more difficult, there are some problems such as high construction safety risk, long exploration period and large investment. The aim of engineering investigation is to find out the geological condition of the project site, but it is more difficult in the projects near or under the road On the other hand, it is necessary to consider the problem of hole arrangement for reconnaissance; if holes are arranged on the existing routes, there is not only the problem of damage to the roads, but also the coordination with the relevant departments in terms of time, personnel, equipment and so on, brought great inconvenience to the investigation.

2.2 Survey on Water

In Water Conservancy and hydropower projects, in order to explore the geological conditions of the strata under rivers, lakes and other waters, rafts and boats are usually used to build platforms to carry out drilling. Unlike land surveys, water surveys should consider not only the problems that may arise from geological conditions, but also the constraints of natural conditions such as waves and currents,

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it greatly affects the efficiency of water exploration and the safety of operators. However, due to the limitation of construction environment, water exploration often needs more complicated equipment and operation, and the construction period is longer, so the construction risk is greater If there are mistakes in the construction process, it is easy to occur on-water platform damage, broken drilling tools and other accidents, serious threat to the safety of personnel and equipment.

2.3 Non-excavation Pipeline Survey

At present, pipeline transportation has become the mainstream mode of oil and gas transportation, so it also drives the development of trenchless pipeline technology. When the trenchless pipeline crosses the special geological conditions, it is difficult to meet the exploration requirements by conventional means, and there are some problems such as large workload and low drilling benefit, and it is difficult to effectively identify faults, fracture zones, caves and other bad geology, can not achieve better exploration results.

3. Feasibility Analysis of Inclined Hole Drilling

The investigation and study found that the application of inclined hole drilling in special working conditions, such as under-crossing roads, can greatly improve the construction efficiency, and inclined drilling reveals more formations and is more accurate and comprehensive than vertical drilling and horizontal directional drilling, it can significantly expand the exploration area and effect, so it has certain feasibility.

3.1 Technical Feasibility

The feasibility of application of inclined hole drilling technology in special working conditions should be considered from the adaptability of geological conditions and engineering applicability.

The adaptability of geological conditions reflects the adaptability performance of inclined hole drilling under special working conditions. In the exploration project of Chaijiagou molybdenum mine [3], slanting hole through the stratum is broken and fissures are developed, which is very disadvantageous to the construction, under the action of casing wall guide and cement slurry wall protection, good economic benefits were obtained. Therefore, in order to meet the requirements of geological adaptation of inclined hole drilling, first of all, reasonable drilling design should be carried out according to the identified geological conditions, and the possible problems should be considered and the countermeasures should be put forward.

The application of inclined hole drilling in special working conditions should include many special working conditions in Iron Engineering, Water Conservancy and Hydropower Engineering. In 1966, the 6200 inclined hole drilling test group of the Second Design Institute of the Ministry of Railways carried out the earliest exploration of horizontal hole and inclined hole drilling in railway engineering, and successfully carried out 8 boreholes; In 2010, a hydropower station in the upstream Irrawaddy River of Myanmar adopted a pair of inclined river-crossing holes with a top angle of 55 ° to identify the width, composition and engineering shape of the downriver fault The inclined hole drilling technique was used in the Sino-Myanmar pipelines project to find out the size of the karst cave and the filling material in the tunnel path. Many engineering cases show that inclined hole drilling has the technical feasibility of unlimited engineering categories in the field of special condition investigation.

3.2 Equipment Feasibility

Inclined hole drilling equipment is generally composed of drilling rig, drill pipe, operating platform, power system and monitoring system [1]. In order to meet the construction requirements of inclined hole drilling, the drilling equipment must satisfy the following conditions: (1) in the construction project, the attitude of the drilling equipment is kept inclined, it is easy to shake, and if it is too heavy, it may collapse, so the quality of the drilling equipment is lighter; (2)the conventional exploration means include static penetration, dynamic penetration and standard penetration, which often need to be completed by more than one equipment, the drilling equipment should integrate many functions and adapt to many kinds of technology, (3) satisfy the adjustment of horizontal and vertical angles,(4)

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operation is simple, the drilling speed and bit direction can be adjusted to adapt to geological conditions and deviation correction; (5) easy to disassemble, assembly, maintenance, low failure rate;(6) real-time monitoring of drilling trajectory. The existing drilling equipment, such as XY-4 drilling rig, is suitable for engineering geological exploration, resource exploration and development and other projects, with reasonable structure, light weight and stable performance, high degree of standardization. Therefore, the application of inclined hole drilling in special working condition investigation is feasible.

3.3 Feasibility of Economic Benefits and Construction Cycle

Shi Lei [4] found that the application of directional drilling technology combined with "One-base multi-hole" construction method can greatly improve drilling efficiency and reduce construction costs. Zhao baoping [5] in the exploration project of slanting hole construction in kaladaban lead-zinc mining area of Aljin Mountain, Xinjiang, mentioned that after the slanting hole construction technology had been perfected, the total work load reached 3825m in 4 months, the utilization ratio of drilling time increased by 17.6% , and better economic and technical indexes had been obtained. Guo Junwen [6] put forward that the application of inclined hole drilling can effectively increase the exploration speed and reduce the construction cost, which is of great significance to enhance the mineral reserves. Yang Hongzhi [7] discovered during the investigation of the Longjiang hydropower station that the faults identified by geophysical prospecting during the feasibility study stage had not been found by using vertical boreholes. Therefore, two inclined boreholes with a depth of 120 m and a depth of 75 ° were designed along both banks of the river for relative construction, it was found that the fault was located between the original vertical drilling holes, and it was concluded that the inclined drilling technique could save a lot of money and work, and make it easier to identify the fault. The above cases prove that the application of inclined hole drilling in special condition investigation has economic benefits and feasibility of construction cycle.

4. Points for Attention in Inclined Hole Drilling

4.1 Layout of Exploration Sites

The layout of inclined hole exploration points should be aimed at the specific engineering design: in the project involving the existing line, the exploration points should be arranged along both sides of the line, which not only satisfy the exploration requirements, but also fully reveal the geological conditions, in general, oblique drilling can only be carried out in the vertical plane on both sides of the railway, and if the road is wide, the target point can be set under the route if necessary. In the hydraulic engineering, exploration sites should be located in more stable areas on both sides of the strait. The exploration points of trenchless pipeline engineering can be arranged at the beginning and end of pipeline section, and the information of vertical borehole and inclined borehole can be verified at a reasonable location.

4.2 Monitoring Measures

In order to prevent drilling from causing excessive disturbance to the existing structures and causing safety accidents, it is necessary to monitor the deformation and displacement of existing structures in real time during the investigation. In case of large deformation, drilling should be stopped in time and effective measures should be taken.

4.3 Hole Wall Stability Control

Good hole wall stability is the primary condition to ensure the successful completion of drilling. The stability of borehole wall is mainly affected by two factors: first, the soil itself, the existing research shows that the stability of borehole wall is closely related to soil cohesion, internal friction angle and groundwater level [8]; The second is the man-made factors: drilling speed, track, in-situ testing on the soil during drilling, mud wall thickness, filling rate and other factors will cause a certain degree of disturbance to the underground soil. Therefore, it is necessary to investigate the geological and hydrological conditions in the site before drilling, design reasonable drilling plans according to

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different geological conditions, and strictly follow the safety operation rules during drilling construction, timely and proper handling of special circumstances.

4.4 Trajectory Control of Inclined Hole Drilling

In the course of drilling, the bit will deviate, on the one hand, because of the bending and jitter of the drill pipe caused by the thrust of the drill pipe and the resistance of the soil, on the other hand, because of the deflection of the bit caused by the uneven soft and hard or special formation, and then affect the accuracy of drilling trajectory. Once the trajectory is offset, the strata may not be fully revealed. The premise of trajectory control is accurate monitoring, it is necessary to install the electronic gyroscope at the end of the bit to monitor the trajectory in real time, through the combination of trajectory monitoring and measurement while drilling matching system, can better grasp and control the change of drilling trajectory, prevent and correct the hole bending or to achieve directional drilling.

5. Conclusion

This paper analyzes the feasibility of inclined hole drilling in special working conditions by studying the engineering characteristics of inclined hole drilling. The study shows that inclined hole drilling is feasible for special working condition exploration in terms of technology, equipment, economic benefit and construction cycle. Based on the characteristics of inclined hole drilling, this paper puts forward some points for attention in special working condition exploration: under the premise of reasonable arrangement of exploration holes according to engineering categories, to ensure the coordination of monitoring measures, hole wall stability control measures and track control measures; Inclined hole drilling can play a good role in special working condition investigation. In addition, inclined hole drilling can be used in conjunction with techniques such as vertical drilling or geophysical prospecting to verify the sourcing circumstances of the inclined hole investigation.

References

[1] Wang Feng, Zhang Qi, Zhao qinglei, etc. . Feasibility of inclined drilling in the investigation of pipeline non-excavation crossing engineering [J] . Oil and Gas Storage and Transportation, 2017,36(10) : 1196-1200.

[2] Li Xin, Li Chenglong, Du Yuben, etc. . Application of inclined hole exploration technology in goaf investigation of Xi'an-Chongqing high-speed railway [J] . High Speed Railway Technology, 2022, 13(02) : 67-70.

[3] Wang Hongtao. Core Drilling Technology for Complex Strata in Chaijiagou Molybdenum Deposit [J] . Drilling Engineering, 2017,44(08) : 37-40.

[4] Shi Lei. High angle borehole drilling in Jingcun Gold Mine, Guangdong Province [j] . Drilling Engineering , 2019,46(06) : 14-18.

[5] Zhao Baoping. Discussion on inclined hole construction technology in Kaladaban lead-zinc mining area in Xinjiang [J] . Technological Development of Enterprise, 2014,33(07) : 52-53 + 65.

[6] Guo Junwen. Discussion on inclined hole construction technology in iron mine [J] . Energy and Energy Conservation, 2020, (05) : 114-115 + 117.

[7] Yang Hongzhi, Sun Guangqing, Zhu Mingyuan, Sun Zhenxi. Drilling method for inclined hole exploration of Longjiang hydropower station [J] . Construction Organization and design, 2005, (00) : 247-248.

[8] Yang Chao, Wang Xiaolong, Chamberlain, etc. Research on hole wall stability and optimization of construction technology of bored pile in inhomogeneous sand layer [J] . Journal of Municipal Technology, 2023,41(06) : 69-75.