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Ultrasonic Logging Instrument for Shaft Sinking by Drilling

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Abstract: Shaft sinking by drilling is widely used in mining, construction and coal industry. Measuring the shaft borehole accurately, is of great importance to the quality in these projects among other factors. This paper proposes a novel design and implementation of ultrasonic logging instrument for shaft sinking by drilling (ULISSD). Design of the ultrasonic ranging module, depth module and the module for downhole orientation, as well as the borehole radius measurement algorithm are explained and illustrated. This paper also demonstrates an experimental application of ULISSD, which shows that, compared with other similar instruments, ULISSD is able to measure accurately borehole shaft radius wider diameters (3-12 meters) at deeper vertical sections (maximum 1,000 meters) in slurry with higher gravity (≤1.22).

Keywords: ultrasonic logging instrument; shaft drilling; borehole measurement

1. Introduction

Shafts are the most important passages to underground operations and shaft sinking technology has always been the focus of most shaft-related studies [1-7]. Shaft sinking methods can be classified into two categories: The conventional and specific. Conventional shaft sinking is generally used for minor shaft projects and in sites with stable strata and alluviums with no or little water inflow. Specific shaft sinking methods, to some extent, complements the conventional methods. There are two specific shaft sinking methods: those by freezing and those by drilling. Shaft sinking by freezing is generally applied in sites with water-bearing or detritus-bearing strata or shafts with extra-large bores (usually≥13ms). By artificially generating low temperature, the semi-fluid soil around the borehole will be solidified by congelation, either to bear stratum pressure or to block quicksand or underground water. Then the final shaft will be constructed within the frozen soil [8,9]. Shaft sinking by drilling is a fully mechanized method and it is widely used in large and deep shaft sites and those sites with unstable alluvium and high density water inflow. This method has been proved to be safe, highly efficient, less costly and generally ensures a better project quality[10,11]. It is generally a successive repetition of the following procedures: cracking strata into drilling bits initially, flushing shaft wall, de-slagging and wall protection with slurry, and finally placing wall after the borehole is drilled to meet all design parameters. This method is popular in shaft construction projects nowadays.

In spite of its inherent advantages, this method entails a major limitation: if the drill rods are not jointed properly, or if the geological parameters of the strata differ much at different sections of the shaft, the drilling borehole may deviate more or less off the designed vertical shaft center. In such cases, shaft projects has to be redone or even be abandoned and this definitely will cause enormous loss. To avoid this, it is
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