Investigation of the depth of steel pile embedment by the integrated geophysical exploration

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In this report, we applied plural geophysical exploration and investigated the cause that a tunneling machine collided in other structure during construction.
A flood gets up in the urban area and becomes the social problem by localized torrential rain in late years. A reservoir to save rainwater is built underground temporarily to prevent a flood. However, a neighboring construction is forced for the underground facilities because the urban area underground is crowded.
We often understand the depth of embedment of the established structure from drawings in the construction under the established structure. However the drawings may be missing with the old structure. When there is a drawing, a trouble may occur while we construct the underground structure because of the difference of the real structure or the depth of embedment.
The depth of embedment of the steel pile is investigated by magnetic survey. However we cannot usually be informed the direction from the borehole using by the conventional magnetic survey. We were developed the borehole vector magnetometer (BVM) to solve this problem (Oshida et al., 2006). BVM is arranged the three component magnetic sensor and measure the three dimensional magnetic fields by the residual and induced magnetization of the steel pile. BVM data estimate a three dimensional position of the tip of pile by analyzed wavelengths and the amplitudes of the three measurement waves.
It was estimated that a tunneling machine had already collide a steel pile by the construction status. It presents the existing abutment pier basement of steel and the complicated structure including the soil retaining piles as well as the steel pile when we confirm the existing drawings. Therefore we planed the BVM and the seismic velocity logging to estimate the depth of embedment of the steel pile. The seismic velocity logging is technique using the transmitted P wave velocity of the steel pile which is larger than that of the soil. We impact the structure itself to produce P wave. Then we can measure the P wave velocity only for steel pile to intend for because P wave does not propagate to other structures. We can estimate that it is an object surely even if the large P wave velocity and BVM anomaly is detected.
As a result of investigation, the following information was provided.
(1) A point of inflection of the travel time curve is accepted in GL-15.5m by seismic velocity logging. This depth is estimated the embedment of the steel pile.
(2) The calculated P wave velocity is the 4.3km/s of the depth zone assumed to be the steel pile by the seismic velocity logging that is clearly larger than the velocity of the soil.
(3) We interpreted difficult to estimate the depth of embedment until GL-14m because the BVM waves of the magnetic fields complicated by the borehole neighborhood construction for example the abutment pier or the soil retaining piles.
(4) However we could estimate the depth of embedment by the independent BVM wave of GL-15.6m, and the depth almost agrees with point of inflection depth of the seismic velocity logging.
(5) We concluded the depth of embedment of the steel pile in consideration both survey results.
(6) We could consider that the tunneling machine is collided the existing steel pile from depth of GL-15.6m because the upper edge of the tunneling machine is GL-14.5m
Even in the case of complicated structure, this report was able to raise its certain result by the integrated geophysical exploration that combined the seismic velocity logging with BVM. The cause

that the depth of embedment deeper than the construction completion drawing is unclear for the moment, but it will be investigated that an underpinning construction and the change of the route are considered based on this result in future.

Keywords: Neighboring construction, Steel Pile, Depth of embedment, Magnetic survey, ,Seismic velocity logging

