

Downhole Magnetometer Survey on the Isle of Dogs

Instrumentation

- Mag-03MSS three-axis fluxgate magnetic field sensor
- Spectramag-6 data acquisition unit

Objectives

The principal aim of this survey was to determine the depth below ground level of the toe of a steel sheet pile that separates the site from the River Thames.

Application

This site is being redeveloped. The client wished to establish the pile length so as to determine whether the existing piles would meet the requirements of the proposed redevelopment.

Background

In April 2013, Arrow Geophysics Ltd carried out a downhole magnetometer survey of two boreholes located at a site in the Isle of Dogs, London E14. The survey was conducted with a Mag-03MSS sensor from Bartington

Instruments, using a Spectramag-6 Data Acquisition Unit for collection and analysis of the data.

The survey aimed to establish the points at which the magnetic field of the pile exerted zero influence and maximum influence on the sensor. As shown in the paper by Jo et al,¹ the toe of the pile can be judged as being at the location midway between these two baselines.

Method

Dynamic downhole measurements were collected in two boreholes from 0m to 20m below ground level, using a logging speed of approximately 1/6 metres per second.

First borehole

This borehole is a horizontal distance of approximately 1.5 metres from the steel pile. Readings for this borehole are shown in Figure 1.

1 Jo, C.H., Cha, Y.H. and Choi, J.H., A borehole magnetic logging tool for estimating unknown foundation depths, Presented at the 3rd International Conference on Applied Geophysics, Dec 8-12, 2003.



The total field magnetic intensity recorded in this borehole varies substantially between 0s (ground level) and 33s, presumably due to the presence of various items of ferrous debris located within the shallow subsurface.

Between 33s and 56s, the intensity stabilises at approximately 30,000nT, which we regard as the unadulterated influence of the sheet pile. Below 56s, the intensity begins to increase to an ambient total magnetic field intensity² of approximately 51,000nT, which is first recorded at 71s. The two baselines of this survey are therefore 56s (full influence of pile) and 71s (zero influence of pile).

Assuming the toe of the steel sheet pile to be located midway along the linear slope connecting the two baselines, this location lies at a recording offset of 63.5s, which equates to an approximate depth below ground level of 10.6 metres.

- 2 The ambient total magnetic field intensity is the intensity which would be recorded at depth within a borehole in the absence of any nearby ferrous material – in other words, the approximate magnetic field of the Earth itself.

Second borehole

Readings for the second borehole are shown in figure 2.

This borehole is located a horizontal distance of approximately 2.7 metres from the sheet pile, compared with a horizontal distance of approximately 1.5 metres for the first borehole. Therefore in the second borehole we would expect a transition of greater width and lower amplitude between the full influence and zero influence baselines.

The rotary borehole log for the second borehole revealed the presence of a 0.3m thick interval of strong dark grey concrete at a depth of 5.0m to 5.3m below surface. This further complicated the interpretation of the total magnetic field intensity log. The narrow peak between 30s and 33s and the broader peak between 33s and 41s in the total magnetic field intensity log are interpreted to be due to steel associated with this concrete, and make it very difficult to determine the start point of the linear slope connecting the two baselines.

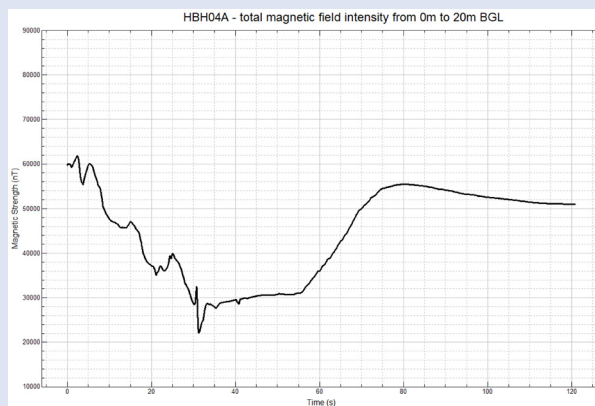


Figure 1: readings for first borehole

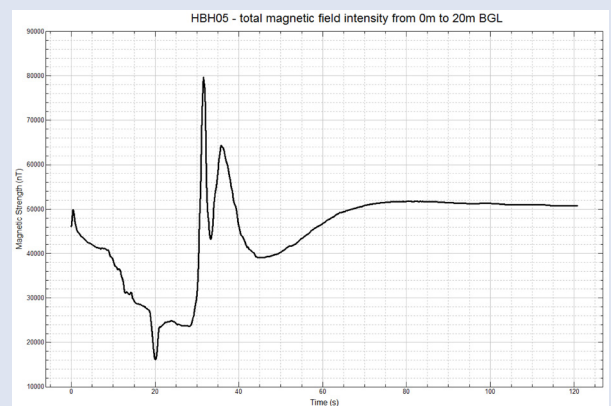


Figure 2: readings for second borehole

In the absence of more diagnostic information, we have interpreted this start point to be located at 46s. The end point of the linear slope has been interpreted at 70s. The location of the toe of the steel sheet pile is therefore interpreted to lie at a recording offset of 58s, which equates to an approximate depth below ground level of 9.7 metres.

Conclusions

A downhole magnetometer survey of two boreholes at a site in the Isle of Dogs has produced interpreted depths below ground level of 10.6 metres and 9.7 metres for the toe of a steel sheet pile located to the east of these two boreholes, separating this site from the River Thames.

These results will help the users of the site to assess the suitability of existing structures for future development.

Note that the influence of the layer of concrete in the second borehole shows that the depth of the pile is best measured from a borehole closer to the pile and as far away as practicable from influences orthogonal to the direction of the pile. Such influences can be uncovered during the boring process.