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Field study on smart monitoring systems using electromagnetic waves for evaluating the integrity of bored piles

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ABSTRACT

Recently, smart monitoring systems using electromagnetic waves have been suggested for evaluating the integrity of steel-concrete structures (Lee et al., 2018; Lee and Yu, 2109; Yu et al., 2018; Yu and Lee, 2020). The objective of this study is to demonstrate the suitability and effectiveness of smart monitoring systems for evaluating the integrity of bored piles. A field study was conducted using an intact bored pile (L = 24.6 m, D = 2.5 m) and a defective bored pile (L = 21.05 m, D = 2.5 m). In the case of the defective bored pile, the reinforcing steel cage is deflected, as shown in Fig. 1. The waveguide system for enabling electromagnetic wave communication comprises a two-conductor transmission line in the bored piles. In the intact bored pile, the two-conductor transmission line is configured by installing a single-conductor electrical wire along the rebar of the reinforcing steel cage, and they are used as the signal and return paths, respectively. For the defective bored pile, the two-conductor transmission line consists of two parallel electrical wires to minimize leakage current into an unwanted conductive path. Four transmission lines were constructed in each bored pile. The electromagnetic waves were generated and detected using a time-domain reflectometer (TDR). The measured signals are shown in Fig. 2. For the measured signal in the intact bored pile (see Fig. 2(a)), reflections of electromagnetic waves were detected only at the head and end of the pile. In addition, attenuation of electromagnetic waves occurred in the concrete section of the intact pile. The average velocity of the electromagnetic waves in the four transmission lines (T1–T4) in the intact pile was 1.150×10^8 m/s, which is similar to the velocities of electromagnetic waves in intact steel-concrete structures suggested by previous studies (Lee and Yu, 2019; Lee

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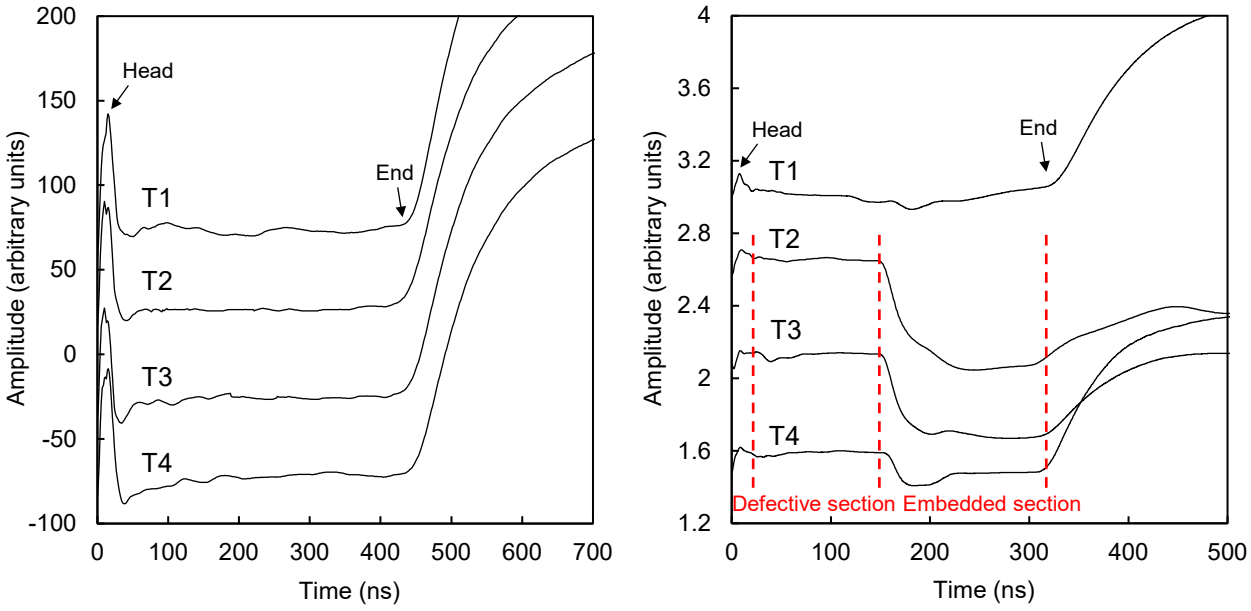
et al., 2018; Yu et al., 2020). In the defective bored pile, reflections of the electromagnetic waves were observed at the head and end of the pile (see Fig. 2(b)), as in the case of the intact pile. However, the amplitude of electromagnetic waves was not attenuated after reflection at the head because the concrete in the upper part of the pile is extremely thin due to the deflection of the reinforcing steel cage. The electromagnetic waves were attenuated in the embedded section, which is after the defective section. This study demonstrated that electromagnetic waves can be a useful tool for evaluating the integrity of bored piles.

(a) Steel cage deflected (b) Steel cage exposed

Fig. 1 Defective bored pile



(a) Intact bored pile (b) Defective bored pile

Fig. 2 Measured signals

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