Ain Shams University
Faculty of Engineering
Structural Engineering Department

Assessment of Pile Integrity Utilizing Full-Scale Non-Destructive In-Situ Testing

By

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A THESIS
SUBMITTED IN PARTIAL FULFILLMENT
FOR THE REQUIREMENT OF THE DEGREE OF
DOCTOR OF PHILOSOPHY

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CAIRO 2009

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Ain Shams University
Faculty of Engineering
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APPROVAL SHEET

Thesis : Doctor of Philosophy Degree in Civil Engineering (Structural Engineering Department)
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Thesis Title : Assessment of Pile Integrity Utilizing Full-Scale Non-Destructive In-Situ Testing

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Date: February 18th, 2009

STATEMENT

This dissertation is submitted to Ain Shams University for the Doctor of Philosophy degree in Civil Engineering (Department of Structural Engineering).

The work included in this thesis was carried out by the author in the Department of Structural Engineering, Ain Shams University from 2002 to 2009.

No part of this thesis has been submitted for a degree or qualification at any other university or institution.

Date : February 18th, 2009

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Abstract of PhD. thesis submitted by:

Anwar Farouk Ibrahim El-Kadi

Title of thesis:

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Supervisors:

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Abstract

Sonic Integrity Testing (SIT) of piles is becoming a very important tool for pile construction quality control, mainly because it is quick, inexpensive and efficient in locating the major defects in a pile. This is referred to the booming in the construction industry leading to the extensive use of piles as foundation structural elements. SIT is a low strain method to characterize pile diameter changes by giving a relation between the pile head velocity versus time and/or depth, interpretation of the results are based on the one-dimensional stress wave theory and require experienced personnel for proper interpretation. SIT is having its limitations in locating some discontinuities (diameter changes) of smaller area/volume relative to the pile cross-sectional area; this is referred to the impact method (impact length) and impact area.

This research is mainly focusing on the effect of using a mechanical hand held hammer and investigating innovative tools for improving the quality of the resulting waves leading to a better and easier identification of the more difficult discontinuities. For this purpose, seven reinforced concrete model piles of the dimensions 35x35x500cm and concrete strength of 25MPa were prepared and tested to represent the different possible construction defects. Also in

this research, a trial was made to utilize the Artificial Neural Networks (ANN) in the interpretation process of the results of SIT.

The research results show that the utilization of a mechanical hand held hammer was very useful to simplify the testing procedure and giving an accuracy and quality in the same range of the conventional hand held hammers with no improvement on the resulting wave quality. At the same time, mechanical hammer combined with contact plates of different configurations resulted in the following main outcomes:

1. Increase of impact area producing shorter wave lengths
2. Generally better wave quality, and easier to interpret
3. A closer match of testing outcome with the theoretical approach

The new introduced methods of impact using a mechanical hammer and a contact plate in its different configurations minimize the difference between the actual testing procedure and the basis of the utilized theoretical tools used for its interpretation.

To overcome the essential need for an experienced interpreter of the test results, trials were made in this research to use ANN in the interpretation of the resulting waves. Very good training results were achieved. However, testing did not lead to the same quality of the training phase. This is referred to the many possibilities of real piles testing results depending on the concrete quality, testing quality, location of defect, and many possible soil configurations. Available possible to use networks might need further developments in order to be able to handle such complex excessive ranges of data. Maybe then, a better chance of creating an interpretation model could be possible.

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Anwar Farouk El-Kadi
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