SUMMARY REPORT 125-7(S)

WAVE EQUATION ANALYSES OF FULL-SCALE TEST PILES USING MEASURED FIELD DATA

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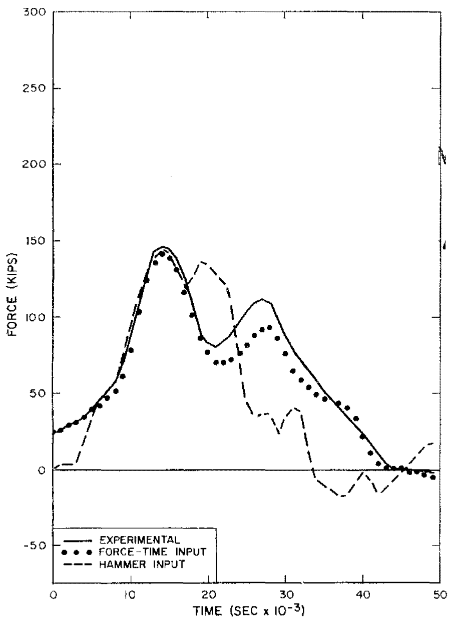

Force-Time Curves at Gage No. 3
for Port Arthur Test Pile No. 1
(Initial Driving)

Cooperative Research Program of the
Texas Transportation Institute and the Texas Highway Department
In Cooperation with the
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Wave Equation Analyses of Full-Scale Test Piles Using Measured Field Data

by

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This investigation was conducted under Research Study 2-5-67-125 entitled "Bearing Capacity for Axially Loaded Piles" which is a cooperative research endeavor sponsored jointly by the Texas Highway Department and the U. S. Department of Transportation, Federal Highway Administration. The broad objective of this study is to develop a procedure whereby the bearing capacity of an axially loaded pile can be determined for any combination of soil and driving conditions.

Research Report 125-7 presents the results of a study which was made to determine soil damping constants used in wave equation analyses of foundation piles. A procedure is developed whereby the damping constants are determined on the basis of field test data obtained from driving and load testing full-scale instrumented piles in sand and in clay. Records of 37 non-instrumented piles are analyzed to determine soil damping constants for other types of soil.

For the instrumented test pile data, the general analytical procedure consists of varying the cushion stiffness and/or the stiffness of the first pile segment until the computed force at the head of the pile matches the actual recorded force at the time the pile was driven. The distribution of frictional soil resistance forces along the side of the pile and the end-bearing resistance at the tip of the pile are determined from soil boring and strain gage data. Finally, the soil damping constants are varied until the best possible agreement is achieved between measured and computed internal pile forces at the gage locations within the pile.

Soil damping constants are obtained from non-instrumented pile data by a trial and error procedure wherein wave equation predictions of pile bearing capacity are correlated with the ultimate capacities of the piles at the time of driving. The 37 additional case records analyzed represent a wide variety of hammers and piles, including steel pipe piles (closed and open end), prestressed concrete piles (constant area and tapered), fluted and tapered steel pipes, and H piles.

The salient conclusions which are drawn from this research are:

1. Soil damping values are not constant, but the use of a soil damping constant for a particular type of soil is justified.

2. Soil damping constants at initial driving and final redriving are the same.

3. A single curve can be used for predicting pile bearing capacity at initial driving and redriving, provided that input values including the ratio of point load to total load do not change appreciably.

4. Soil damping constants of $J = 0$ and $J' = 0.2$ should be used for friction piles in clay; $J = 0$ and $J' = 0.5$ should be used for piles in saturated sand and silt.

5. The most critical input parameters for wave equation analyses are ram velocity, cushion or first pile segment stiffness, load distribution, and soil damping constants.

6. The cushion stiffness or first pile segment stiffness controls the magnitude of the dynamic peak force at the pile head when the ram velocity and soil resistance are held constant.

7. The soil damping constants control the magnitude of the dynamic peak forces along the pile when the cushion or first pile segment stiffness, the ram velocity, and soil resistance are held constant.

Based on the results of this study, the following recommendations are offered:

1. A simple device for measuring the dynamic peak force at the pile head during initial driving or redriving should be developed and incorporated into the hammer-pile-soil system.

2. Methods of static analyses should be investigated to develop a procedure for determining pile load distributions that produce consistent results in predicting pile bearing capacities by wave equation analyses.

3. Penetrometer test values should be investigated to determine if they can be effectively related to pile load distributions for wave equation analyses.

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