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THE EFFECT OF LONG INSTALLATION ON THE PILE CHARACTERISTICS

BY

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ABSTRACT:

This article investigate the effect of long installation on the pile characteristics for cast in-place vibro piles. Twentey one non destructive integrity tests using the mechanical impedance steady state dynamic method were done on 21 piles having long installation time. All tests except one show that the piles considered to be sound. A load test on one pile gives gross settlement of 4 mm under 1.5 of the working load.

INTRODUCTION:

Driving of large numbers of piles in sandy soil at Maadi star project, Cairo for high rise towers caused a densification of sand which caused difficulties of hard driving and long exetracting times as shown in Table 1. It was believed that, this phanomena may cause defects for piles and disturbe the fresh concrete of the piles. Integrity non destructive tests were done on 21 piles of long installation time to check the homogeneity and continuity of the piles shafts to localize the presence of any major faults. The piles were cast in place vibro type using casing closed at its end by a steel shoe with diameter 18 (560 mm) and depths were vary between 16 m to 18 m. The soil condition at the site were approximately as follows:

0-3 m: brown silty clay
3-7 m: fine silty sand
7-9 m: fine to medium sand.
9-12m: medium to coars sand.
12-16m: coarse sand and gravel.
16-20m: medium to coares sand.

The SPT and cone test results are shown in Fig.(1).

The Test Method:

An electrodynamic vibration motor is mounted on the head of the pile. This motor is controlled by a sinusoidal current generator of variable frequency from 20 to 1000 Hz. The motor, of mass M, vibrates in the vertical plane, and imports a force F to the head of the pile such that F M, were is the acceleration of the mobile M. A regulator is used to maintain constant the force F applied to the pile. The energy transmitted to the head of the pile travels down the pile to the ancharge zone at the base, which in turn reflects part of this energy back towards the pile head. The velocity of the pile head results from the combination of the incident and reflected energies. The pile head velocity shows very marked maxima and minima at certain values of frequency f.

A velocity transducer and a recorder facilitate the analysis of the movement of the pile head, as well as the ploting of the change in velocity as a function of the excitation frequency. Knowning the constant amplitude of the applied force F, it is possible to calculate the mechanical admittance $\left|\frac{V}{F}\right|$ for each frequency. The interpretation of the curve $\left|\frac{V}{F}\right|$ as a function of frequency provides the required information concerning the foundation quality (anchorage, stiffness, continuity, presence of faults, etc...).

Test Results:

Test results for each pile are given in the table of results and response curves are included in appendix.

The first graph plotted is always the V/F value against 1000 Hz frequency scan to measure the pile length. The vertical scale is noted on the left hand side. The second graph is V/F against only 100 Hz frequency scan to measure the flexibility and the stiffness at low frequency (16 Hz). The vertical scale is also noted at the left hand side.

In assessing the piles, 3 parameters have been considered:

- measured response compared with given length,
- dynamic stiffness (in MN/mm),
- N value = 1/ ρc.Ac.Vc., which measures the cross sectional area and the concrete quality.

Response Measurements:

Pile lengths are calculated by:

$$L = \frac{Vc\ (m/s)}{2\,\Delta f\ (Hz)}$$

where Vc is the velocity of propagation plane waves in concrete and Δf range of frequency measured between resonating peaks on the response trace.

Resonance can occur from various levels:

- the pile toe,
- a defect such a necking, discontinuity, crack,...
- a bulb in the shaft,
- soil interfaces.

It is usual to calculate l with two values of Vc:

Vc = 3500 m/s for a medium concrete,
Vc = 4000 m/s for a good concrete.

The piles can be classified in two groups:
- Those with the measured lengths based on Vc 4000 m/s corresponding to the previous theorical toe piles n 13.40. 81. 119. 127. 145. 150. 195. 197. 234.

- Those with intermediate reflections due to soil interfaces which have masked out any response from the toe:
- at 5/7 m in fine to medium sand, piles 18. 41. 151.
- at 9 m in medium to coarse sand, piles 114. 117. 118.
- at 13 m, anchorage in coarse sand and gravel, piles 3. 29. 112. 146. The pile n 2 shows a response at 1.50 m corresponding to a bad concrete at the top.

N values:

The theoretical value of N 1/ $\rho c.Ac.Vc$, where

ρc = concrete density.
Ac = cross sectional area

are calculated for two couples of values:

. For a poor concrete ρc = 2200 kg/m^3
Vc = 3000 m/s
N = 6.20 x 10^{-7}

. For a good concrete ρc = 2400 kg/m^3
Vc = 4000 m/s
N = 4.30 x 10^{-7}

It is clear that a high N value indicates a reduction in section and/or poor quality concrete, a low N value an oversize section and/or above average quality concrete. All the tested piles gave normal or low N values except pile n 2, which has a high N value indicating a defect at the top of the pile. On the other hand, pile n 18 has a high stiffness value coupled with a low N value a low N value indicating oversized shaft (over volume of concrete poured in this pile).

Dynamic Stiffness E^*:

The dynamic stiffness plotted on the graphs shows.

- Stiffnesses of average of 1.17 MN/mm are recorded, which is a high value for such small diameter piles.
- The higher values are found with piles having intermediate responses (n 18. 41. 117) indicating oversized shaft at these levels.
- Pile n 2 has the lowest value (0.27 MN/mm) coupled with an intermediate response at about 1.50 n due to bad concrete at this level.

CONCLUSIONS:

The effect of long installation of cast in place vibro piles on the pile characteristics was little, only one pile shows a deffect from total 21 non destructive integrity testing using the mechanical impedance steady state dynamic test.

An explanation may be due to delayed of concrete setting due to flow of water caused by the increasing of pore water pressure during pilling process. Hobb (1957) found that the setting time of concrete may be delayed to 3 hours in his work.

A load test on pile no. 40 gave only 4 mm gross settlement under 1.5 the working load.

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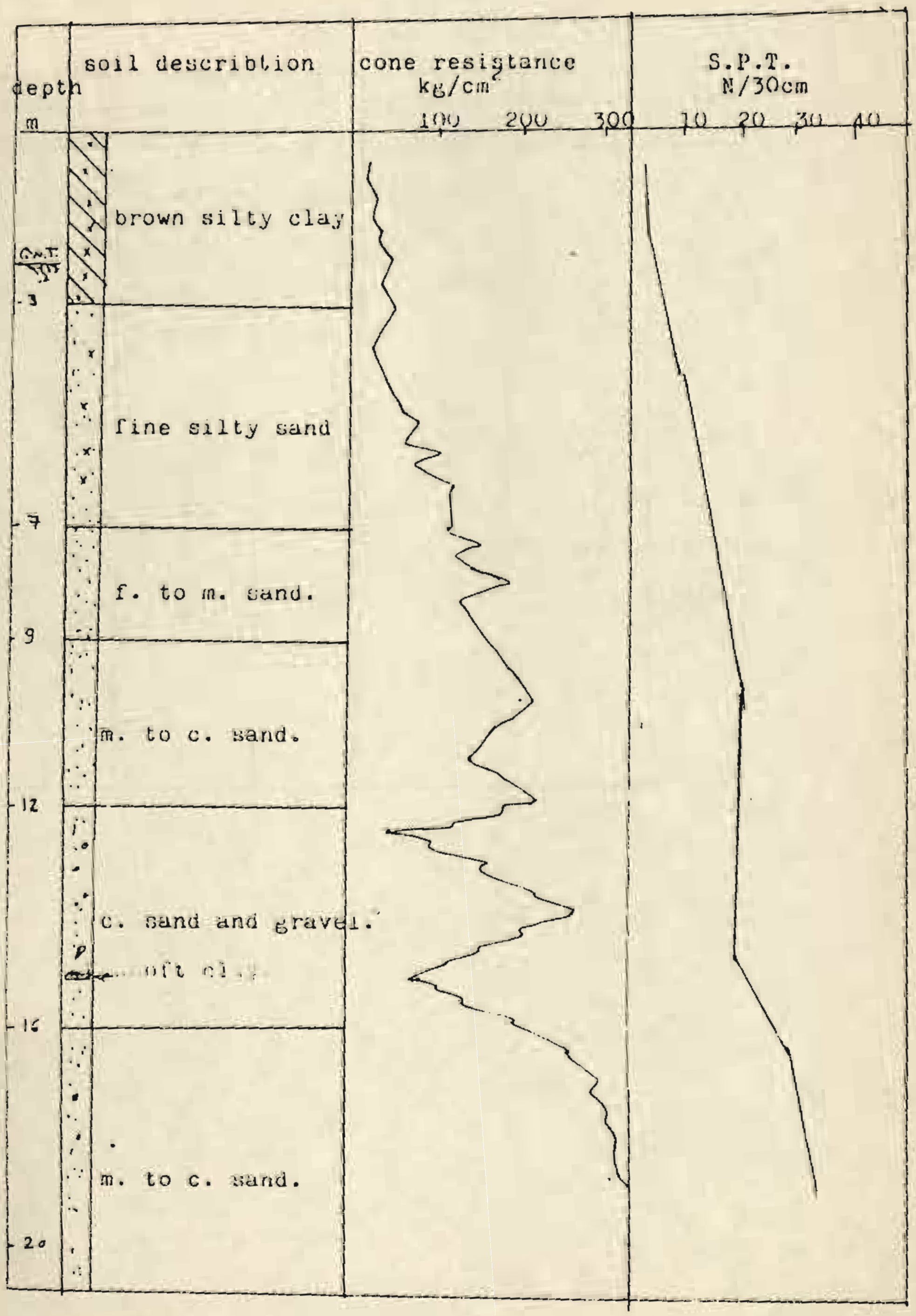
depth
m
soil describtion
cone resistance
kg/cm²
S.P.T.
N/30cm
100
200
300
10
20
30
40
brown silty clay
3
fine silty sand
7
f. to m. sand.
9
m. to c. sand.
12
c. sand and gravel.
16
m. to c. sand.
20

fig. 1.

Long installation piles

pile no.	driving time hrs	exetracting time hrs	pile no	driving time hrs	exetract time hrs
2	1.9	2.2	117	2.25	2.35
3	1.8	2.0	118	2.50	2.40
13	1.05	2.35	119	2.20	3.0
18	2.0	3.30	145	2.30	2.50
29	2.0	2.30	146	1.45	1.90
40	1.6	2.20	150	1.8	2.15
41	2.05	2.30	151	1.45	3.0
81	1.91	2.20	195	1.9	2.8
112	1.45	2.0	197	2.0	2.10
114	2.10	2.20	234	1.75	2.0

table 1.

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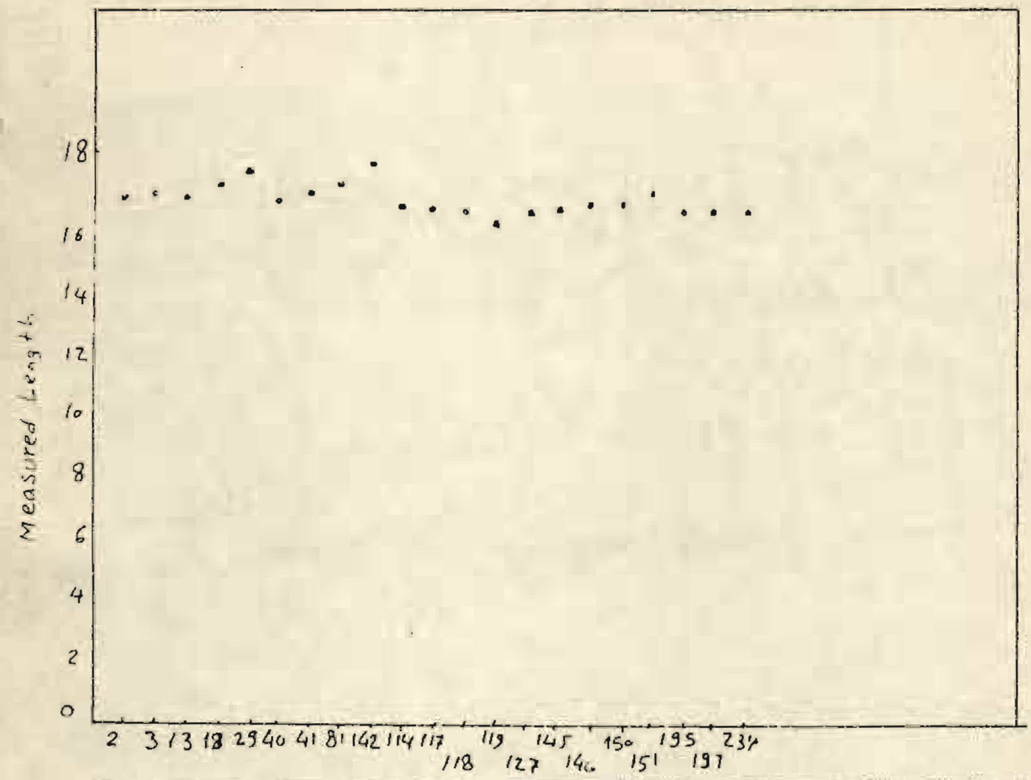
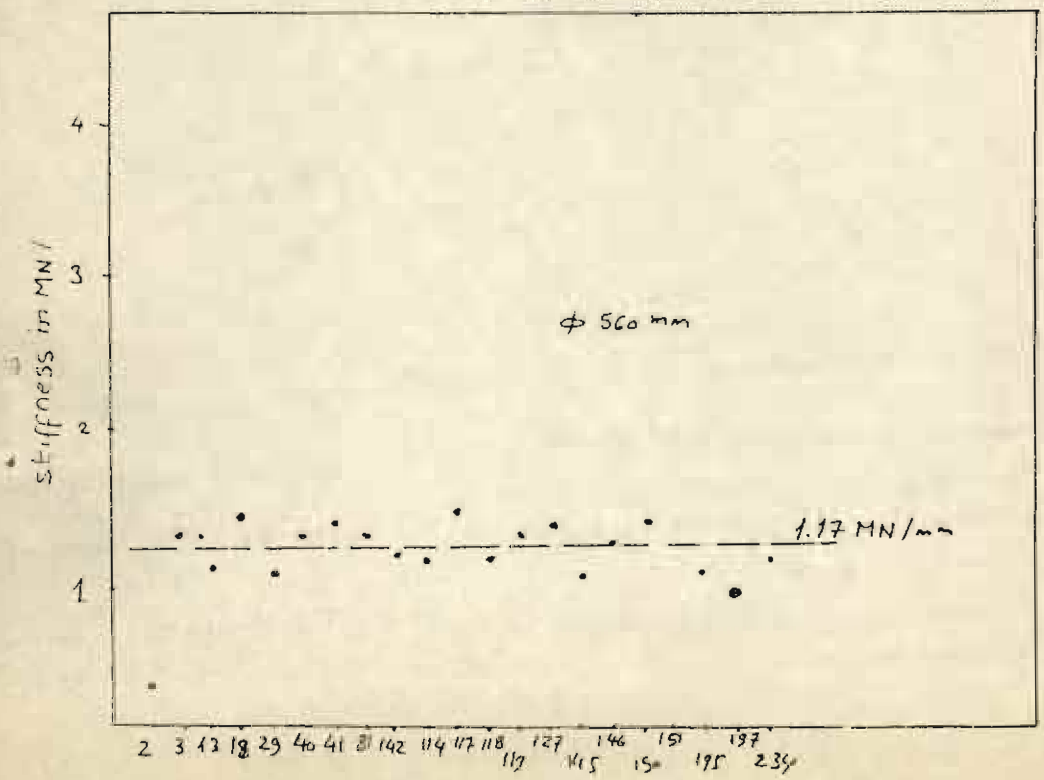
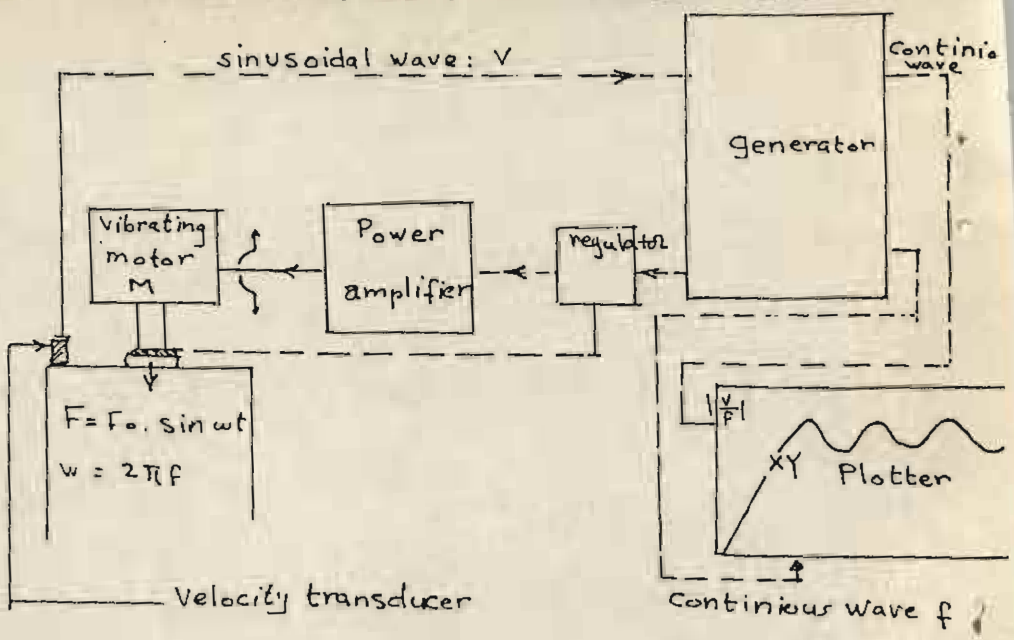
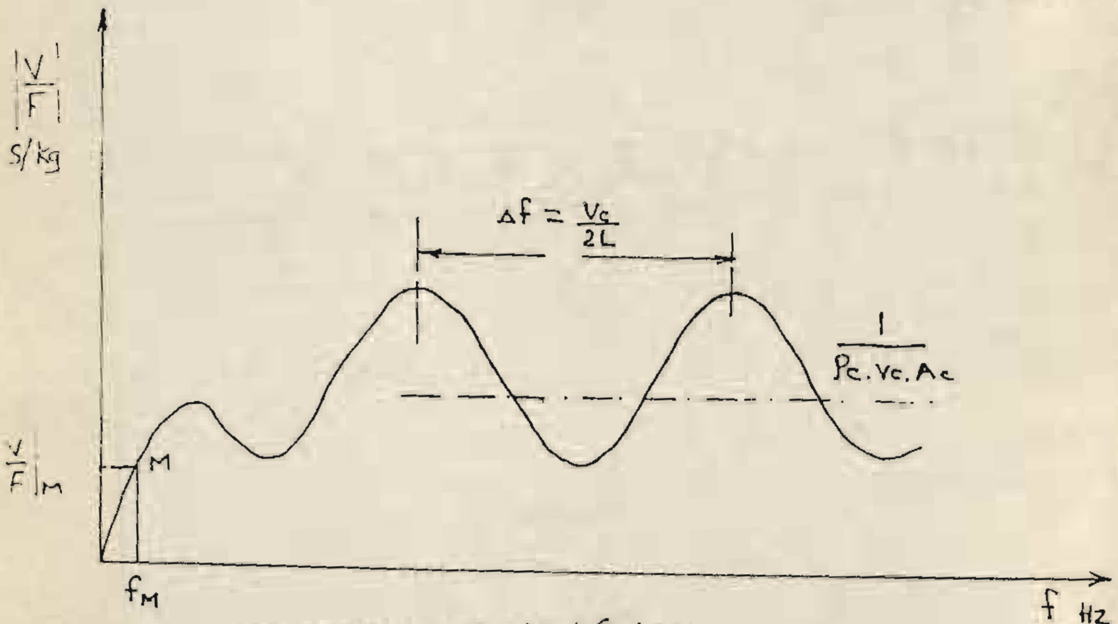




Principles of vibration method





V = Measured velocity of pile head (m/s)

F = Applied force in Newtons (N)

Δf = Range of frequency in Hz.

L = Length of pile (m),

Vc = Velocity of propagation wave in concrete

ρc = unit weight of Concr

Ac = Cross-Sec. area of pile

|V/F| = mechnical admittan of pile (s/kg)