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определению отклонений наружной поверхности стен от вертикали с уточнением конструктивных решений крепежных узлов вентилируемых фасадов. [5]

Список использованных источников

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APPLICATIONS OF PILE DYNAMIC AND STATIC TESTS IN ASTANA, KAZAKHSTAN

A.R. Omarov
Ph.Dr Student, Eurasian National
A.Zh. Zhussupbekov Professor, Eurasian National University

Abstract

This paper includes the short summary about dynamic and static soil tests by driven piles with square cross-section (30×30 cm and length of 12 m) commonly used for the problematic soil conditions of Astana. The definitions and determination methodologies of the pile bearing capacity by aforementioned methods were also given. As an example for those methods, paper describes the results of the dynamic, static and the new in Astana PDA (Pile Dynamic Analyzer) tests of soils by piles performed in the construction site of the “New Railway Station”. The possible depth of piling and piles bearing capacity were determined according to the results of tests. As well as the recommendations for the device of working piles of construction project were issued.

Keywords: pile, loading, dynamic tests, static tests, PDA.

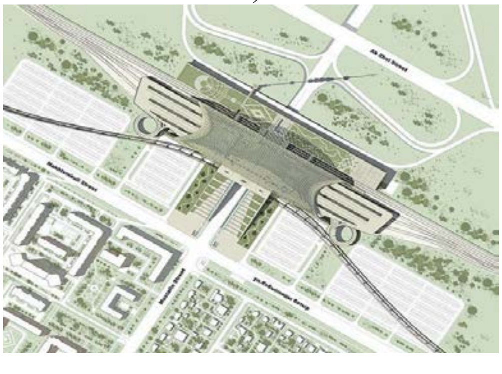
Introduction

High rates of constructing and the appearance of high-rise buildings in Kazakhstan with their complications require the use of pile foundation. Most often pile foundations are used in the regions as Astana, Atyrau, Karaganda and Shymkent.

The pile types applied currently for construction of buildings in Kazakhstan are as follows: driven square piles (30×30 cm), H-beam steel piles and bored piles installed in the casing tube, bored piles through CFA (Continues Flight Auger) and FDP (Full displacement Piles) technologies.

Field tests of trial driven piles (C12-30) by dynamic and static loads in the construction site of railway station (Figure 1) were carried out in accordance with the requirements of [1]. Bearing capacity of the piles was determined using the methodology described in [2]. PDA tests were performed in accordance with the requirements of [3].

a)



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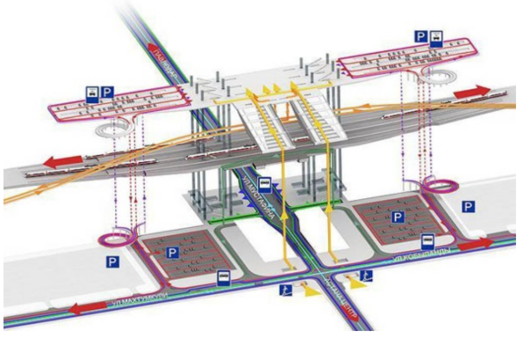

Figure 1. New Railway Station project: a) master plan, b) layouts

Methodologies of the field tests

Dynamic load test (DLT)

In Kazakhstan, DLT is carried out using different types of pile driving machine hammers. Before starting the test, pile surface alone the whole length is painted through each 1 m by marks; last one meter is painted each 0.1 m.

For our project pile driving was performed using the piling machine "Junttan PM-25" using hydraulic hammer HHK-7A with the weight of 7000 kg and headband weight of 990 kg.

During the pile driving process (Figure 2) the number of blows of the each 1 meter of pile penetration into the soil ground and of the last one meter in each 0.1 meter were counted. The falling heights of blowing part of the hammer were recorded at the same time. Pile driving was continuing till the design refusals (cm/blow).

Figure 2. DLT of piles using driving machine Junttan PM-25

The highest average refusal received during the driving of piles after their "rest" was used for the determination of bearing capacity of piles. According to [2], the rest time for the piles immersed into clayey soils should be 6-10 days, for sandy and gravelly soils – 3 days.

Re-driving of test piles was carried out sequentially by three and five hammer' blows. The strain gauges with the length of 10 cm were attached on top of the piles before starting re-driving. They were controlling each 1 mm of dynamic penetration of the pile and used for PDA method (Figure 3).

Figure 3. Preparation of the piles for the PDA

Bearing capacity of the piles (Fu) from DLT results was calculated using the following equation:

$$Fu = \frac{\eta AM}{2}\left[\sqrt{1+\frac{4E_d}{\eta AS_a}\frac{m_1+\varepsilon^2(m_2+m_3)}{m_1+m_2+m_3}}-1\right] = 756 \text{ kN}, \quad (1)$$

where: η - factor depending on the concrete strength of the piles; A = 0,009 m^2 – area of the pile cross-section; M = 1 – factor, depending on the hammer's impact; S_a – average refusal from one blow, m; m_1 – total weight of the hammer; ε^2 – factor, ε^2 = 0.2; m_2 and m_3 – weight of pile and cap, t; E_d – effective energy of blows of the hammer (kN*m), calculated as:

$$E_d = GH, \tag{2}$$

where: G – weight of blowing part of the hammer, kN; H - falling height of blowing part of the hammer, m;

Considering the factors of safety for DLT equal to 1,4, bearing capacity of the piles were equal to 540 kN.

Pile Dynamic Analyzer (PDA)

Figure 4 presents the monitoring results of PDA showing pile dynamic compression and tension stresses, static pile capacity and blow counts versus pile penetration depth. CAPWAP analysis results that include plots of measured pile head data obtained under the hammer blows from the end of driving and associated simulated pile head and toe static load-movement relationships are presented in the Figure 5.

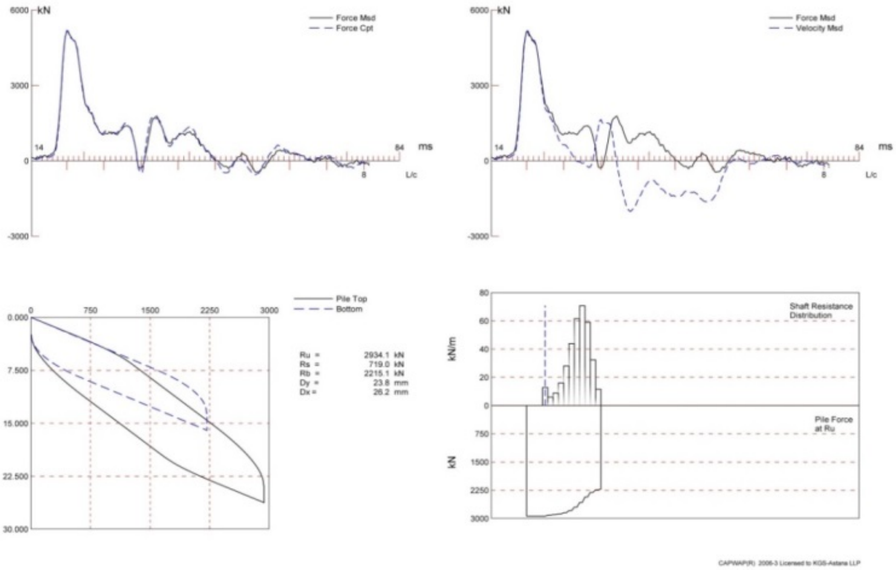

Figure 4. CAPWAP results (Fu= 2934.1 kN)

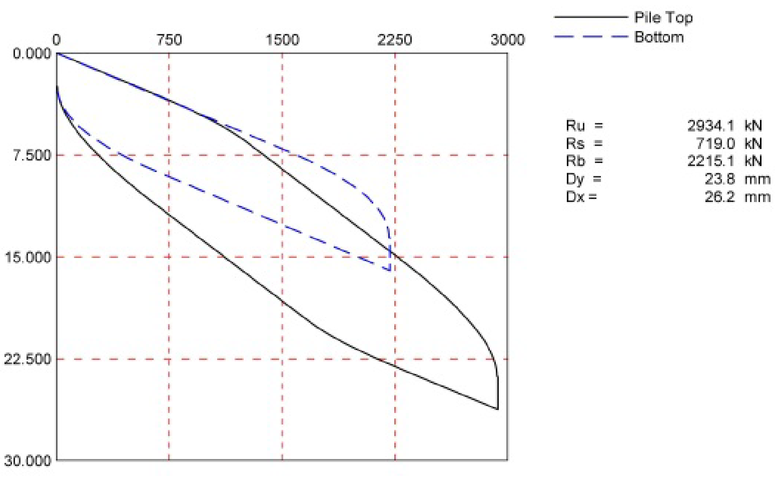

Figure 5. Load-settlement diagrams for the determination of bearing capacity of the piles in PDA

Static loading test (SLT)

SLT of driven piles were carried out after their "rest".

For the SLT in the project the pressure in the jack SMJ-158A-200 was created using the manual oil pump station MNSR-400 with the power up to 800 kg/cm2. The pile settlement was measured using the equipment namely 6-PAO, which were positioned on both sides of unmovable bearings of the benchmark system.

In each step of loading measurements from all devices were taken according to this sequence: zero reading – before the pile loading, firs reading – immediately after applying the load, then sequentially four readings by intervals of 30 minutes and further every hour up to achieving conditional stabilization of deformations. As a criterion of conditional stabilization of deformations at the given loading step was taken a velocity of displacement that not exceed 0,1 mm for the last 1-2 hours (Figure 6). Unloading was performed by loading steps equal to two times of loading values, with measurement of readings at least each 15 minutes for each step. According to SLT result, the load-settlement diagrams were drawing (Figure 7) and compared with PDA results (Figure 8).

Figure 6. SLT of the piles

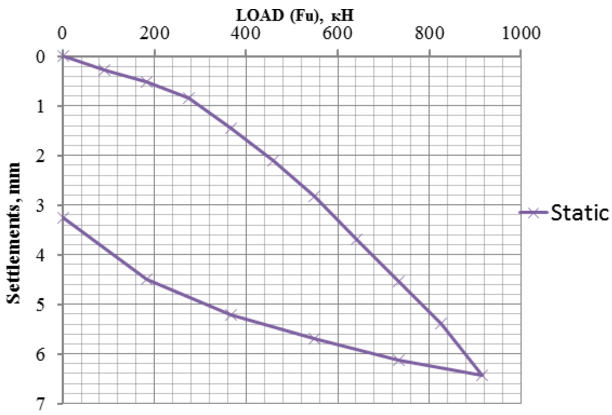

Figure 7. Load-settlement diagram from SLT results

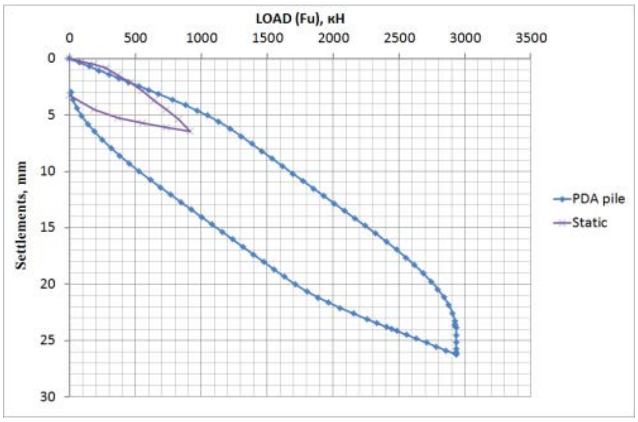

Figure 8. Comparisons of SLT and PDA load-settlement diagrams

As the particular value of ultimate resistance of piles (Fu = 915 kN) the loading value corresponding to the settlement S was taken. This settlement is calculated by the following equation:

$$S=\zeta \cdot S_{u,mt}, \tag{3}$$

where: $S_{u,mt}$ – ultimate value of the average settlement of pile foundations of designing building; ζ = 0.2 – conversion coefficient from the ultimate value of the average settlement to the settlement, obtained in the SLT after the conditional stabilization of the settlement.

Bearing capacity of piles based on the results of SLT, considering the safety factor 1,2 [3], was calculated and equal to 782,5 kN;

Conclusion

1. According to the results of DLT of driven piles (30 × 30 cm and length of 12 m) the bearing capacity of the piles amounted to be 540 kN.
2. The bearing capacity of driven piles according to the results of SLT amounted to be 782,5 kN.
3. According to the results of PDA, bearing capacity of the piles are equal to 2934.1 kN;
4. There is a need in doing research of PDA between equation and dynamic formula.

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ИСПЫТАНИЕ СВАЙ ДИНАМИЧЕСКОЙ НАГРУЗКОЙ НА ПЛОЩАДКЕ СТРОИТЕЛЬСТВА «НОВОГО ВОКЗАЛА» В ГОРОДЕ АСТАНА

А.Р.Омаров, Ф.Р.Жанабаев