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Application of in-situ static load test of pile in Nur-Sultan

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ABSTRACT: The paper presents discussions of the bearing capacities of precast concrete piles from construction site of the Construction of multifunctional family-entertainment and tourist area in the city of Nur-Sultan, Kazakhstan. According to the design drawings construction site was planned to be installed by precast concrete piles. PCPs were composed with cross-section of 30 cm × 30 cm with the length of bottom segment 7.0m. In paper presented in-situ static vertical loading tests on C7-30 driven piles were carried out on the construction site of the Parking Zone P1, P2 of the Project 'Construction of multifunctional family-entertainment and tourist area in the city of Nur-Sultan, from 05 to 13 February, 2021. The permissible load on the pile, taking into account the safety factor γ_k =1.2 in accordance with Standard should be taken equal to – 681 kN, 800 kN respectively.

Keywords: load-settlement, in-situ SLT tests, pile

1 INTRODUCTION

1.1 *Construction site*

In-situ static load tests on C7-30 driven piles on the construction site of the Project 'Construction of multifunctional family entertainment and tourist area in the city of Nur-Sultan, were carried out by specialists of KGS-Astana LLP according to the Agreement with Renaissance Construction JSC.

Characteristics of the tested piles: Driven pile C7-30, section 30x30 cm, length 7.0 m (Figure 1).

Figure 1. Mounting kentledge system.

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Table 1 presented absolute elevations of piles P480, P1210.

Table 1. Absolute elevations.

Pile number	P480	P1210
- soil surface at the pile	345.66	345.66
- pile heads	346.36	346.36
- pile bottom	339.36	339.36

Transportation, installation of the test and loading stand and cargo was carried out from 04.02.2021 to 11.02.2021.

2 RESEARH METHODS

2.1 *Equipment and devices*

Testing and loading stand. Support structure for the reception of reactive forces: main beam, support platform and load piles. Hydraulic jack. Loading for testing with static vertical driving loads shall be performed with an Enerpac CLS2006 185 ton hydraulic jack. Pressure gauge. The pressure shall be recorded by a MA100VU100 type pressure gauge with a graduation rate of 20 bar (kgf/cm2) up to 1000 bar (kgf/cm2).

Displacement measuring sensors. Pile displacements shall be measured by four digital electronic converters of 028DG1, 028DG2 and 028DG3 type. Digital dynamometer. The load shall be recorded by a digital Load Cell type dynamometer connected to the SLT2 system. Pumping station. The hydraulic jacks are pressurized with a P462 hand pump. Reference system. A steel equal angle 63x63x5, 4 m long, fixed to the reinforcement, driven into the ground to a depth of at least 1.0 m shall be used for the reference system. SLT2 monitoring systems. The instruments of SLT2 static load test monitoring system are specially designed to monitor static load tests and report data in accordance with Eurocode 7.

Figure 2. Assembling loads during mounting kentledge system.

This system allows monitoring the static load tests from a distance of up to 25 m, without the need for personnel to approach potentially hazardous system components that are under high load. The pile load was created using an Enerpac CLS 2006 185-ton hydraulic jack with an Enerpac P462 pumping station, resting against a test and loading stand, weighing 120.0

tons. The load was recorded with a pressure gauge up to 1000 atm. (kgf/cm2) of the MA100VU100 type with a graduation rate of 20 atm. (kgf/cm2) and a digital dynamometer of the Load Cell type connected to the SLT2 monitoring system (Figure 2).

The movement of each pile was measured by four digital electronic displacement transducers of 028DG1, 028DG2, 028DG3, 028DG4 type working in conjunction with SLT2.

The SLT2 system monitoring devices are specifically designed to monitor static pile load tests for the purpose of obtaining results in accordance with Eurocode 7 standards. This system gives an opportunity for controlling the static pile load tests at a distance of up to 25m. This system allows personnel (testers) to remotely monitor the pile settlement and the actual load on the pile, without approaching the potentially dangerous area of the test site structure, where the system is under high pressure and load.

3 DISCUSSION

These pile tests shall be carried out with static loads to establish the actual bearing capacity of the pile. A pile shall be loaded with a static vertical-driving, stepwise-increasing load, in accordance with the Table 2.

Table 2. Program of pile test.

Load step number	Loading per step		Total load:	
	kgf/cm2	kN	kgf/cm2	kN
1	40	104	40	104
2	40	104	80	208
3	40	104	120	312
4	40	104	160	416
5	40	104	200	520
6	40	104	240	624
7	40	104	280	728
8	20	52	300	780
9	20	52	320	832
10	20	52	340	884
11	20	52	360	936
12	20	52	380	988

The vertical load shall be brought to a value that causes the pile to move by at least 40 mm or to the maximum load provided for by this program (Figures 3 and 4).

Figure 3. Reference system with displacement transducers, hydraulic jack Enerpac CLS 2006, Load cell Comp load 100t.

Unloading of the tested piles shall be carried out in steps equal to the double loading steps, in accordance with the Table 3.

Table 3. General unloading pile.

Unloading step number	Unloading per step		General unloading	
	kgf/cm2	kN	kgf/cm2	kN
Unloading				
1	40	104	340	884
2	40	104	300	780
3	60	156	240	624
4	80	208	160	416
5	80	208	80	208
6	80	208	0	0

Figure 4. General view of the kentledge system with a container for test.

Strain gauge readings shall be taken immediately after each unloading step and observed after 15 minutes. After complete unloading (to zero), elastic displacements shall be monitored for 1 hour, with readings taken every 15 minutes.

In the course of the tests, a log of the established form shall be maintained, according to the test results, graphs of the dependence of the pile settlement on the load $S = f(p)$ and the change in the settlement according to the load steps $S = f(t)$ in time shall be plotted.

In the process of testing, in parallel with the electronic data collection by the SLT2 static load test monitoring system, a log of in-situ pile tests shall be maintained in accordance with GOST 5686-2012.

Table 4. Results of SLT of pile.

Pile	Pile cross section	Max applied	Displacement, mm	Bearing capacity, kN	Permission design load, kN
P480	30*30	936	40.62	818	681
P1210		988	40.56		

Table 4, Figure 5 presented results of piles P480 and P1210.

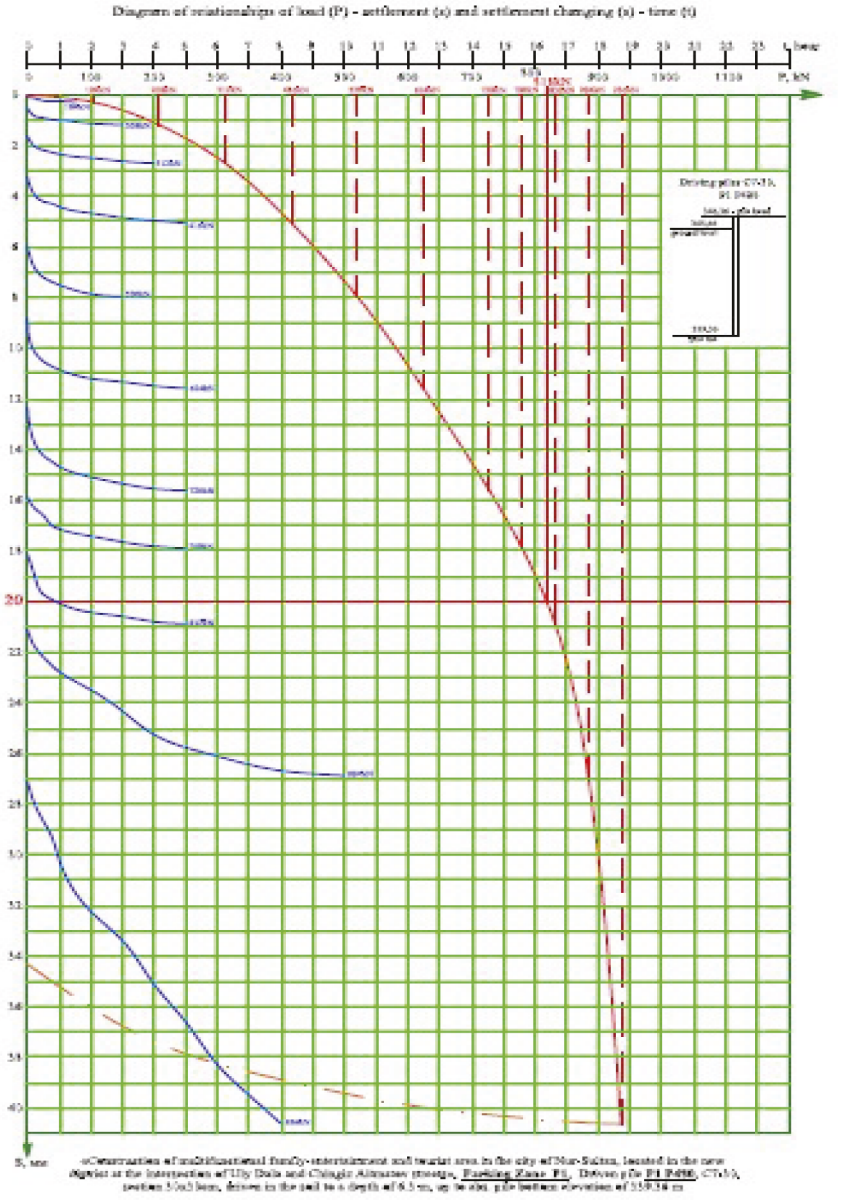

Figure 5. Results of SLT.

4 CONCLUSION

On the construction site of the Parking Zone P1 of the Project 'Construction of a multifunctional family-entertainment and tourist area in the city of Nur-Sultan, static tests of two C7-30 driven piles driven in the soil to a depth of 6.3m up to the abs. pile bottom elevation of 339.36 m were carried out from 05 to 13 February, 2021. The bearing capacity of the piles, according to the results of their static load tests at the above construction site, was 818 (Eight hundred and eighteen) kN. The permissible load on the pile, taking into account the safety factor γ_k =1.2 in accordance with Clause 4.4.1.11. SP RK 5.01-103-2013 'Pile foundations' should be taken equal to – 681 (Six hundred eighty-one) kN.

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