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A.S. Tulebekova[1,3], Ye. Ashkey[2], A.K. Zhankina[1,3]

[1]Kazakhstan Geosynthetics Society, Nur-Sultan, Kazakhstan
[2]KGS-Astana, LTD, Nur-Sultan, Kazakhstan
[3]L.N. Gumilyov Eurasian National University, Nur-Sultan, Kazakhstan
E-mail: krasavka5@mail.ru, yrgenashkey@mail.ru, zhankina90@mail.ru

Experience in pile testing on different construction sites

Abstract. The paper presents the experience of soil testing with piles at various construction sites in Kazakhstan. Different methods are chosen in the field tests depending on the engineering and geological conditions and objectives. The choice of each is guided by the use of special equipment and devices. Soil tests with piles have an advantage to date. It is important to determine the size and type of piles that will be used in the foundation. The maximum depth of the pile is checked with the predicted load. The paper presented discussion of the technical features of each method, the justification of the selected solution. Analysis of experience is a very important aspect, of the successful implementation of megaprojects and new construction.
Keywords: field test, soil, features, pile, bearing capacity, device.

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Introduction

Accumulated in the field of development and implementation of construction projects, advanced urban planning ideas, and best practices can be the basis for quality and reliable construction, as well as serve the emergence of new ideas and improve the methodology of engineering and geological studies. The various methods used on construction sites in the world are presented in Table 1[1].

Table 1

Testing methods for foundation [1]

Preliminary survey		**Geological investigations inthe design stage**		**Control investigations**	
Investigation of the topographical and hydrogeological maps, archival material, geological investigations	Clay soil (CPT, SS, DP, SPT, GW, PMT)	*pre-selection of the type of foundation*	pile foundation WST, CPT, DP, SPT, FVT, PMT, PIL	*The final choice of the type of foundation*	pile foundation pile; sonic pile test; GWC; measurementof settlement
			shallow foundation WST, CPT, DP, FVT,DMT, PMT,GW, BJT		shallow foundation control of type of soil; CPT, control ofthe settlement
	Sandy soil (CPT, SS, DP, SPT, GW, PMT, DMT,GW)	*pre-selection of the type of foundation*	pile foundation CPT,DP, SPT,FVT,DMT, GWO,pile integrity tests	*The final choiceof the type of foundation*	pile foundation pile; sonic pile test;GWC measurementof settlement
			shallow foundation CPT+DP, SPT, PMT, BJT, GWO		shallow foundation control of the type of soil; CPT, control of t settlement

Weight sounding test (WST); Cone penetration test (CPT); Dynamic probing tests (DP); Standard penetration test (SPT); Field vane test (FVT); Pressure meter test (PMT); Static axially loaded compression

The advantages of field testing methods are shown in Figure 1.

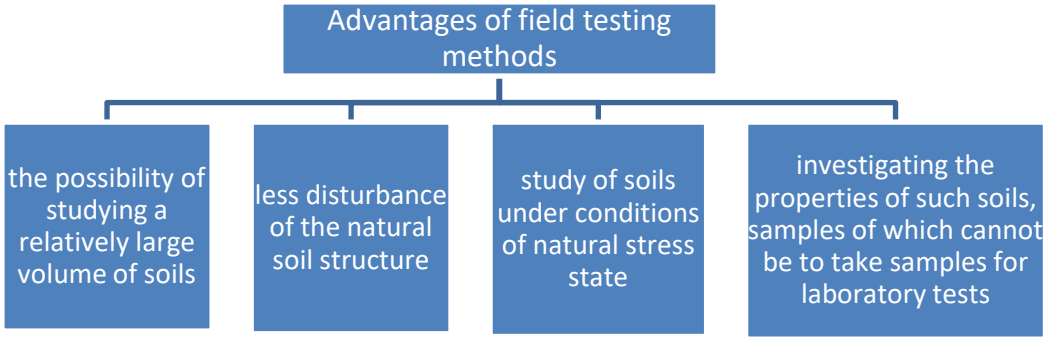
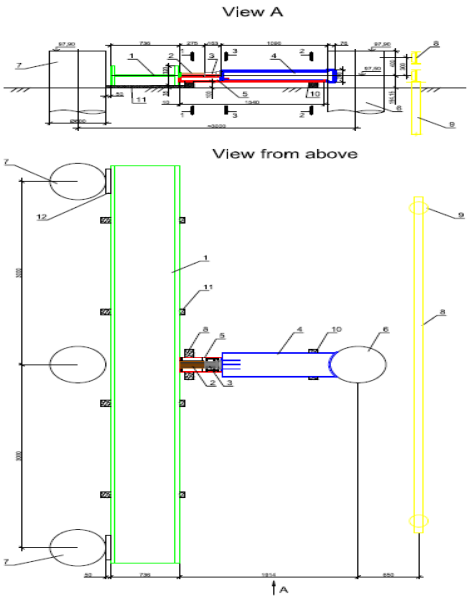


Figure 1. The advantages of field testing methods

Methods of field soil investigations provide data on the physical and mechanical properties of soils at depth [2-3]. It is very important to take an integrated approach to geotechnical studies, combining several methods of testing, which allows you to get comprehensive information and avoid errors [4].

Methods and Materials

Static load tests involve determining the allowable settlement to the ultimate test load and the bearing capacity of the pile. Pilot sites were equipped with the CFA method of bored pile driving, in which, after the auger reaches the design depth, the pile is concreted through a concrete pipeline installed in the hollow auger with the help of a concrete pump. The reaction system for lateral load test CFA piles is presented in Figure 2[5].



1-main beam; 2-hydraulic jack; 3- load cell; 4- reaction beam; 5- channel; 6- test pile; 7- reaction piles; 8-reference system; 9-screw metal piles for reference systems; 10,11- wooden lining; 12- steel plate

Figure 2. The reaction system for lateral load test CFA piles

The auger itself is extracted from the pile body at the same time. After the concreting is completed, a reinforcement cage is loaded into the pile by means of a vibratory plunger, and then the anchor stand metal structures are installed and the anchor rods are welded to the anchor piles. The static lateral load test is presented in Figure 3[5].

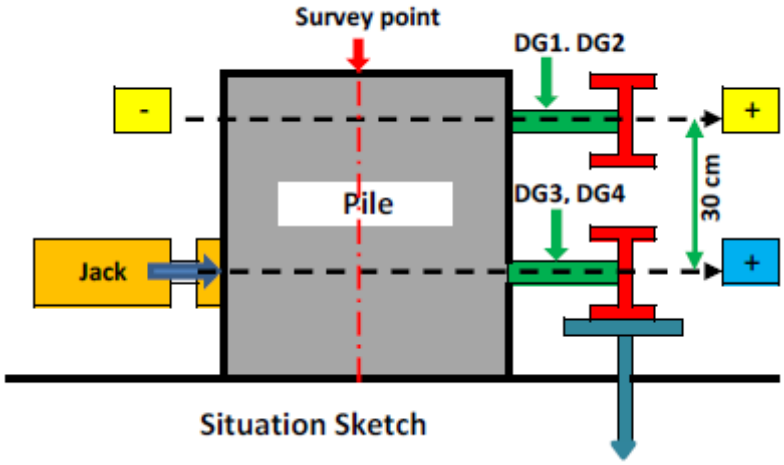


Figure 3. Situation sketch

Table 2 is presented data of 1 cycle load of 150% loading and unloading.

Steps №	Pressure gauge, bar	Load		Average settlement, mm								Rate of measurement, mm/h		Time holding Load,min
		Incrementally	Incrementally,kN	Loading/unloading		At the endurance time		At the step time		Full				
		DG1, DG2	DG3, DG4	DG1,DG2	DG3, DG4	DG1,DG2	DG3,DG4	DG1,DG2	DG3,DG4	DG1, DG2	DG3,DG4	DG1, DG2	DG3 ,DG4	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	60	25	20	0.035	0.065	0.065	0.045	0.100	0.110	0.100	0.110	0.000	0.000	120
2	120	50	40	0.080	0.095	0.100	0.075	0.180	0.170	0.280	0.280	0.020	0.010	120
3	180	75	60	0.185	0.160	0.110	0.085	0.295	0.245	0.575	0.525	0.030	0.025	120
4	240	100	80	0.210	0.190	0.180	0.160	0.390	0.350	0.965	0.875	0.040	0.040	120
5	300	125	100	0.170	0.150	0.290	0.255	0.460	0.405	1.425	1.280	0.075	0.060	120
6	360	150	120	0.190	0.170	0.300	0.280	0.490	0.450	1.915	1.730	0.065	0.065	120
7	240	100	80	-0.170	-0.220	-0.010	-0.010	-0.180	-0.230	1.735	1.500			15
8	120	50	40	-0.455	-0.400	-0.0	-0.010	-0.455	-0.410	1.280	1.090			15
9	0	0	0	-0.465	-0.415	-0.170	-0.165	-0.635	-0.580	0.645	0.510			60

The second construction site is located in the Almaty region, Kazakhstan. At the same time, the loads on the tested pile were transmitted centrally and coaxially. To perform static tests, an individually designed test stand was used in the form of a thrust structure to absorb reactive forces, developed in accordance with the requirements of GOST 5686-2012[6]. In the applied construction of the test stand, the pile head loads are created due to the pressure in the hydraulic circuit of the jack system. The load-carrying structure consists of an anchoring unit. The maximum penetration load on the tested pile was -160.0 Tf. The force generated by the jacks on the first load step was 16.0 Tf, each successive load step had

an increase of 16.0 Tf. General view of the measuring system is presented in Figure 4[7].

Figure 4. General view of the measuring system [7]

At each stage of pile loading, readings (test information) were taken by all instruments at intervals from 15 to 30 minutes, the total dwell time was at least 180 minutes or until the pile movement (settlement) faded, called its conditional stabilization. According to the pile design, its displacement (settlement) rate in the ground, according to GOST 5686, of no more than 0.1 mm for the last 60 minutes of observations at a given stage of loading was taken as conditional stabilization of the pile. Zero reading from the instruments was taken before the pile was loaded. The first reading was immediately after the application of the first loading stage, then the readings were taken every 15 min successively up to four times, then three times 30 min or until the deformation stabilization (damping of displacement). The holding time of each stage, from the first to the ninth, under indentation loads was 180 min for each stage. Data of loading and unloading were presented in Table 3[7].

Table 3

Data of loading and unloading

Loading steps	Force by the jack, Tf
1	16.0
2	32.0
3	48.0
4	64.0
5	80.0
6	112.0
7	128.0
8	289.0
9	144.0
10	160.0
Unloading steps	
1	128.0
2	96.0
3	64.0
4	32.0
5	0

Study of the length and pile integrity, by carrying out full-scale express control of the continuity of reinforced concrete bore piles by non-destructive method of acoustic defectoscopy, in accordance with the provisions of the STP RK 07-02.2-2011. The testing pile presented in Figure 5.

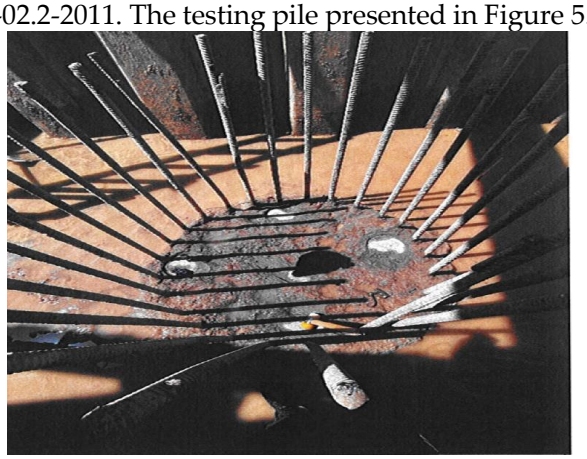


Figure 5. Pile integrity test [7]

Results and discussion

The results of soil testing of construction site 1 presented in Fugure 6 and construction site 2 in Figure 7.

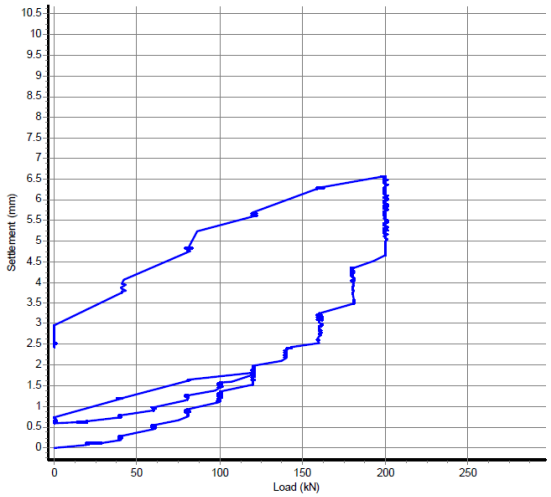


Figure 6. Settlement Graph

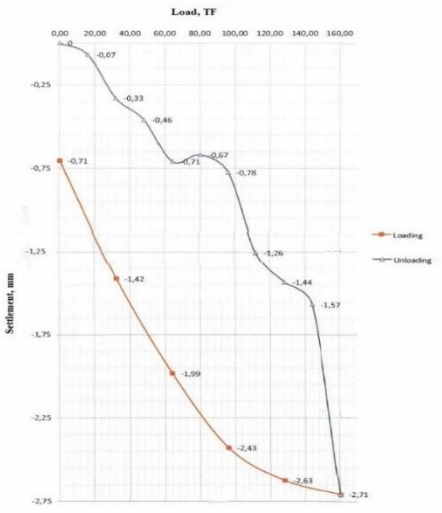


Figure 7. Graph of the results of all stages of testing

The static test of the pile with indentation loads showed that at the tenth stage of the load at the maximum indentation load equal to 160.0 Tf a stabilization of the pile deformation was recorded, at that averaged settlement by the last averaged measurement of the control devices (indicators) was about 2.71 mm. According to SP RK 5.01-103-2013 [8] in case of the occurrence of these conditions for the limiting resistance of the pile under the indentation loads, according to the results of the conducted tests, the load of 160.0 Tf. The analysis of settlement increment graphs shows the operation of foundation soil in the elastic stage. The test results show that the bearing capacity of the pile is sufficient to withstand the maximum design indentation load. Regarding results of pile integrity test was that the actual measured length, after statistical processing, is estimated as corresponding to the design one. Taking into account the peculiarities of the method and the hardware error of the device. Zones of violation of concrete continuity and decompaction in the cross-section of pile were not detected.

Conclusions

Many factors guide the choice of the field test method, some of which are soil composition, soil condition, complexity categories of geotechnical conditions, design loads, embedding depths, and the type of foundation to be designed.

Quality control of pile installation works needs to ensure plumpness, pile toe, pile length, details of the reinforcing steel, concrete samples for the strength test. Data on the preparation of reinforcement, quality, and volume of concrete must record in the pile installation log. Field tests should be combined with other methods determining the composition, condition and properties of soils in order to interpret the data, identify relationships between soil characteristics determined by different methods, and assessment of their reliability. According to the analysis of the research conducted, various research methods were used and in combination

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С. Тулебекова[1,3], Е. Ашкей[2], А.К. Жанкина[1,3]
[1]Қазақстан геосинтетикалық қоғамы, Нұр-Сұлтан, Қазақстан
[2]ЖШС KGS-Astana, Нұр-Сұлтан, Қазақстан
[3]Л.Н. Гумилев атындағы Еуразия ұлттық университеті, Нұр-Сұлтан, Қазақстан

Қадалармен топырақтың статикалық сынақтарын жүргізу ерекшеліктері

Аңдатпа. Мақалада Қазақстанның түрлі құрылыс алаңдарында қадаларға топырақ сынақтарын жүргізу тәжірибесі ұсынылған. Далалық сынақтар кезінде инженерлік-геологиялық жағдайлар мен міндеттерге байланысты әртүрлі әдістер таңдалады. Олардың әрқайсысын таңдау арнайы жабдықтар мен құрылғыларды қолданумен байланысты. Бүгінгі таңда қадалар көмегімен топырақты сынау айтарлықтай артықшылыққа ие. Іргетаста қолданылатын қадалардың мөлшері мен түрін анықтау маңызды. Қаданың максималды тереңдігі болжамды жүктемені ескере отырып тексеріледі. Жұмыста әр әдістің техникалық ерекшеліктері, таңдалған шешімнің негіздемесі талқыланады. Тәжірибені талдау өте маңызды аспект, мегажобаларды сәтті іске асыру және жаңа құрылыс болып табылады.

Түйін сөздер: далалық сынақтар, топырақ, сипаттамалары, қадалар, жүк көтергіштігі, құрылғысы.

А.С.Тулебекова[1,3], Е.Ашкей[2], А.К.Жанкина[1,3]
[1]ОО Казахстанское Геосинтетическое Общество, Нур-Султан, Казахстан
[2]ТОО KGS-Astana, Нур-Султан, Казахстан
[3]Евразийский национальный университет им. Л. Н. Гумилева, Нур-Султан, Казахстан

Опыт проведения испытаний свай на различных строительных площадках

Аннотация. В статье представлен опыт проведения испытаний грунтов сваями на различных строительных площадках Казахстана. В зависимости от инженерно-геологических условий и задач при полевых испытаниях выбираются различные методы. Выбор каждого из них обусловлен использованием специального оборудования и приборов. Испытания грунта с помощью свай на сегодняшний день имеют значительное преимущество. Важно определить размер и тип свай, которые будут использоваться в фундаменте. Максимальная глубина погружения сваи проверяется с учетом прогнозируемой нагрузки. В работе представлено обсуждение технических особенностей каждого метода, обоснование выбранного решения. Анализ опыта является очень важным аспектом, успешной реализации мегапроектов и нового строительства.

Ключевые слова: полевые испытания, грунт, особенности, свая, несущая способность, устройство.

Information about authors:

Tulebekova A.S. – Ph.D., Associate Professor, Member of Kazakhstan Geosynthetics Society, L.N. Gumilyov Eurasian National University, Nur-Sultan, Kazakhstan.

Ashkey Y. – Manager at KGS-Astana, LTD, Nur-Sultan, Kazakhstan.

Zhankina A. – Ph.D. student in Construction, Member of Kazakhstan Geosynthetics Society, L.N. Gumilyov Eurasian National University, Nur-Sultan, Kazakhstan.

Тулебекова Ә.С. – Ph.D., доценті, Қазақстан Геосинтетикалық қоғам мүшесі, *Л.* Н. Гумилев атындағы Еуразия ұлттық университеті, Нұр-сұлтан, Қазақстан.

Ашкей Е. – ЖШС KGS-Astana компанияның менеджері, Нұр-сұлтан, Қазақстан.

Жанкина А. – Құрылыс кафедрасының докторанты, *Л.* Н.Гумилев атындағы Еуразия ұлттық университеті, Қазақстан Геосинтетикалық қоғам мүшесі, Нұр-сұлтан, Қазақстан.