DOI 10.52209/1609-1825_2023_2_238 UDC 624.154.1

Analysis of Complex Tests of the Module Piles in Difficult Soil Ground

[1]**OMAROV Abdulla,** *PhD, Acting Associate Professor, omarov_01@bk.ru,*
[1]**ZHUSSUPBEKOV Askar,** *Dr. of Tech. Sci., Professor, astana-geostroi@mail.ru,*
[1]***TLEULENOVA Gulshat,** *PhD, Acting Associate Professor, gulshattleulenova23@mail.ru,*
[2]**ORAZOVA Dinara,** *PhD, Associate Professor, dinarzhan_84@mail.ru,*
[1]*NPJSC «L.N. Gumilyov Eurasian National University», Kazakhstan, Astana, Satpayev Street, 2,*
[2]*NCJSC «Toraighyrov University», Kazakhstan, Pavlodar, Lomov Street, 64,*
**corresponding author.*

Abstract. *The purpose of the scientific work is comparative analysis using Static compression load test (SCLT) and Dynamic load test (DLT) methods to determine of bearing capacity of pile foundations in difficult soil ground. Mega project is the construction site of Cargo offloading facilities (COF) in Atyrau region. In project used 2 consists module piles. Precast concrete module piles have 16 meter piles and 11.5 meter (9.5 m) piles with joint a total length of 25.5 m and 27.5 m, cross section 40×40 cm. The design of pile foundations was carried out in accordance with the requirements of regulatory standards. DLT testing method is also need for assessment of bearing capacity for module piles. Numerical modeling of piles was carried out in the Plaxis 2D program. The interaction of module piles with difficult of soil ground of West Kazakhstan is presented.*

Keywords: *module pile, load, settlment, tests, bearing capacity, Static compression load test, Dynamic load test, normative standard, numerical modeling.*

Introduction

Berthing facilities (COF) occupy the area with plan dimensions 281x660 m. The projected area of berthing facilities ensures creation of berthing area of construction support base. COF construction consist of pile driving and installation of piles for head walls and unloading platforms, mechanical dredging in front of the retaining walls to the design depth, and also in embankment pitching.

Application of piles in difficult engineering and geological conditions requires the development of the most optimal calculation methods.

This working plan (WP) is driving operations of precast concrete piles consists of two segments, segment 1 and segment 2 are interconnected that supply the segment 1 length 16 m, segment 2 lengths 9.5 and 11.5 m, the total lengths 25.5 and 27.5 m, the reinforcement diameter of 8 mm with a cross section 400x400 mm [1-5]. Technical characteristics of piles presented in table 1.

In figure 1 presented driving module piles in difficult geological conditions.

Research methods

There are presented several methods using in construction site COF in Atyrau region.

Testing of piles for loading and unloading static and dynamic tests was carried out according to the program in accordance with the requirements of the standards [3-7]. For composite pile No. K-3, the load was 1,639 kN (equal to 125%), and for other piles, the maximum load was 3,278 kN (equal to 250%) of the workload [8].

Result and Discussion

Module piles have several results No. TR-03, No. TR-02 and No. TR-01.5, the curve line in the «Load-Settlement» there is a change in the trajectory of the curve of composite piles No. TR-02 and No. TR-03, characteristic of the stage resistance is to creeping soil.

For comparison, data from field studies and nu-

Table1 – Pile information

Pile	Pile 1	Pile 2	Pile 3
Cross section, cm×cm	40×40	40×40	40×40
Pile length, m	25.5	27.5	25.5

Figure 1 – Construction site of COF

Figure 2 – Motion sensor

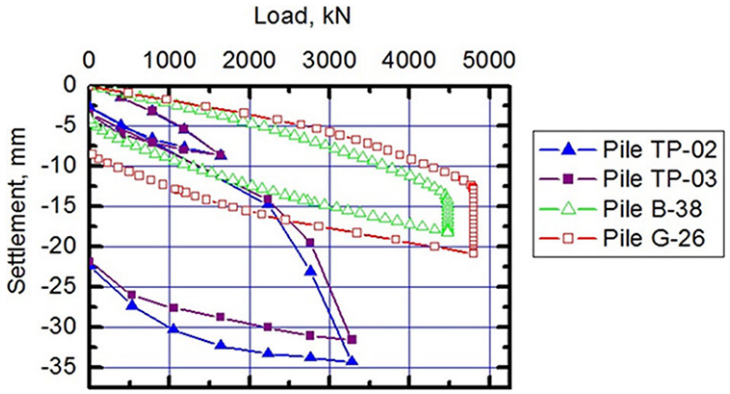

Figure 3 – Results of SCLT and Dynamic load test

merical modeling were obtained.

Vertical movement isolines for composite piles with a length from 22 meters to 27 meters (Pile 22 m – Pile 27 m) (Figure 5).

The superposition of lines there is change in the trajectory of the curve depend on pile. A pile with a length of 22 meters

The piles had a settlement of 30.58 mm, and with a maximum length of a composite pile of 27 meters, the settlement was 25.43 mm (Figure 6, table 2).

The results on the ultimate resistance of piles to the indentation load under the influence in which

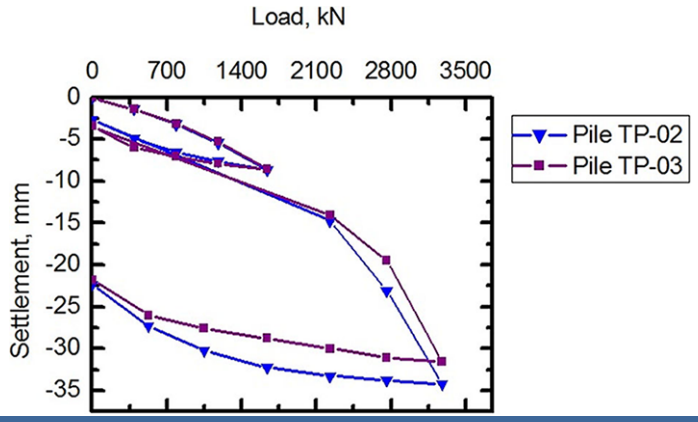

Figure 4 – Load-Settlement graph

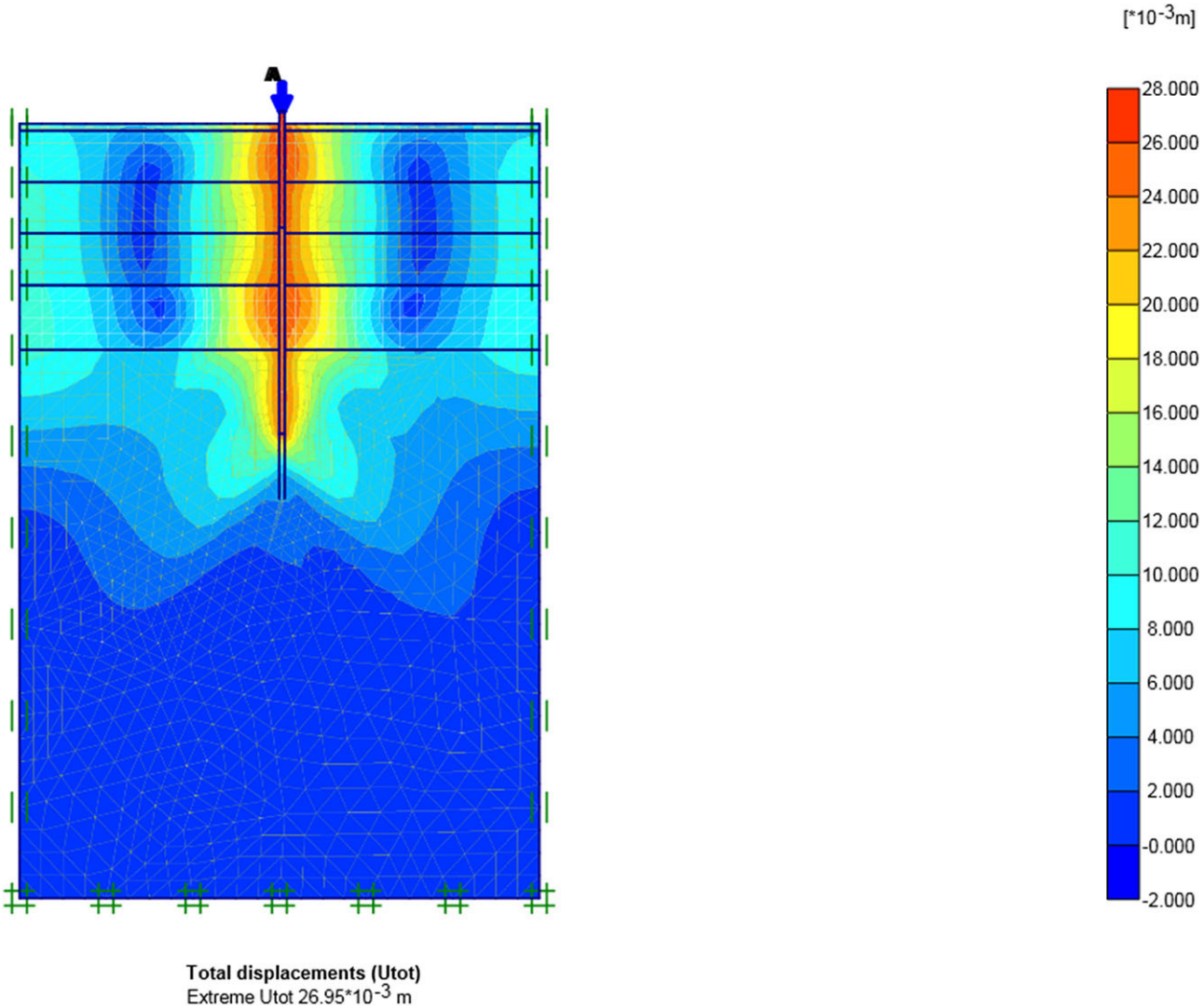

Figure 5 – Vertical movement isolines of pile

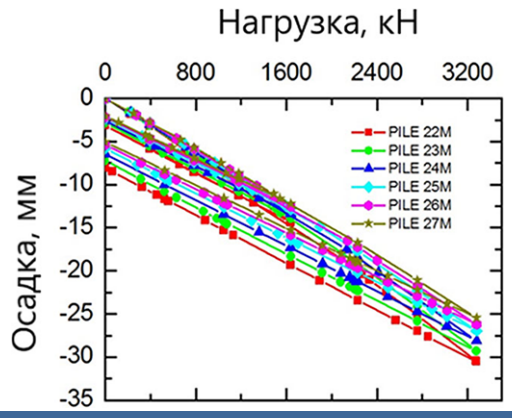

Figure 6 – Vertical movement (Pile 25 m)

the tested pile received 16 mm of precipitation can be seen in Table 3.

Conclusion

The estimated bearing capacity of the driven pile with a cross section of 40x40 cm and a length of 25 m was 2400 kN, which confirms the sufficient bearing capacity of the foundation soils for piles of this depth of immersion.

The method of testing composite piles by the SCLT method is demonstrated in accordance with normative. Module piles by the SCLT method, results are 2,067 kN, 2,042 kN and 2,333 kN, respectively, for pile lengths from 23 m to 26.75 m, and these values do not exceed the values of the maximum bearing capacity according to the Davisson limit limitation method.

According to the research results, the similarity of the obtained data on SCLT and DLT methods (after CAPWAP interpretation) was revealed and minor deviations of DLT from SCLT equal to 7% were found, which does not worsen the quality indicators.

As a result, vertical displacements for composite piles with a length of 22 meters to 27 meters (Pile 22 m – Pile27 m) from 25 mm to 30 mm were determined with a fixed draft of 16 mm was compared.

Table 2 – Analysis of complex tests and calculations

Test methods	FS (safety coefficient)	Settlement, mm	Bearing capacity before FS	Bearing capacity after FS	%
SCLT (№. TP-02) ASTM	1.2	22,91	2480	2067	100
SCLT (№. TP-03)	1.2	-	2450	2042	99
DLT (№. B-38) ASTM	2	18,18	4471	2236	109
DLT (№. G-26) ASTM	2	21,30	3904	1952	95

Table 3 – Results of loading piles

№	Number of piles	Results of loading piles
1	pile 22m	1727 kN
2	pile 23m	1815 kN
3	pile 24m	1883 kN
4	pile 25m	1975 kN
5	pile 26m	2139 kN
6	pile 27m	2229 kN

Acknowledgments: *This research has been is funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP13268718. Development of an innovative methodology for determining the bearing capacity of micropiles by bi-directional static load).*

REFERENCES

1. Geotechnical Interpretation Report. Cargo. Project: WBCAS134-3.TN.028.F01, Atyrau, 2014. – 78 p.
2. Zhussupbekov, A.Zh., Omarov, A.R. Analysis of effect of pile driving on the existing foundation // Bulletin Construction and Architecture, Volume 7, 2016. – Pp. 132-138
3. Zhussupbekov, A.Zh., Lukpanov, R.E., Omarov, A.R. Experience in Applying Pile Static Testing Methods at the Expo 2017 Construction Site // Journal of Soil Mechanics and Foundation Engineering, Volume 53, Issue 4, 2016. – Pp. 251-256.

4. Zhussupbekov, A., Omarov, A., Yergen, A., Tleulenova, G., Borgekova K. Investigations of Interaction of Joint Piles with Problematical Soil Ground in Kazakhstan // Proceedings of Seventh International Conference – GeoMate 2017, Geotechnique, Construction materials and Environment, TSU, Mie, 2017. – Pp. 283-388.
5. Zhussupbekov, A., Shakhmov, Zh., Tleulenova, G. Application Static Load Test (SLT) and Pile Integrity Testing (PIT) of piles in sea port «Prorva» (West Kazakhstan) // Proceedings Fourth International Conference on Science, Engineering & Environment. – Nagoya, 2018. – Pp. 1129-1134.
6. SNIP RK 5.01-03-2002. Pile foundations, Almaty: KazGOR, 2003. – Pp. 27-29.
7. SNIP RK 5.01-01-2002. Foundations of buildings and structures, Almaty: KazGOR, 2003. – Pp. 18-22.
8. Zhussupbekov, A., Omarov, A. Modern Advances in the Field Geotechnical Testing Investigations of Pile Foundations // Procedia Engineering, Volume 165, 2016. – Pp. 88-95.

Күрделі топырақ жағдайында модульдік қадаларды кешенді сынауды талдау

*[1]**ОМАРОВ Абдулла Рахметович,** PhD, доцент м.а., omarov_01@bk.ru,*
*[1]**ЖУСУПБЕКОВ Аскар Жагпарович,** т.ғ.д., профессор, astana-geostroi@mail.ru,*
*[1]***ТЛЕУЛЕНОВА Гульшат Толеувна,** PhD, доцент м.а., gulshattleulenova23@mail.ru,*
*[2]**ОРАЗОВА Динара Казбековна,** PhD, қауымдастырылған профессор, dinarzhan_84@mail.ru,*
[1]«Л.Н. Гумилев атындағы Еуразия ұлттық университеті» КеАҚ, Қазақстан, Астана, Сәтпаев көшесі, 2,
[2]«Торайғыров университеті» КеАҚ, Қазақстан, Павлодар, Ломов көшесі, 64,

**автор-корреспондент.*

***Аңдатпа.** Ғылыми жұмыстың мақсаты – күрделі топырақ жағдайында қадалардың іргетастарының көтергіш қабілетін анықтау үшін статикалық сынақ (SCLT) және динамикалық жүктеме сынағы (DLT) әдістерін қолдана отырып салыстырмалы талдау өткізу. Мегажоба – Атырау облысындағы жүктерді түсіру бойынша құрылыс алаңы. Жобада 2 модульдік қадалар пайдаланылды. Құрама бетоннан жасалған модульдік қадаларда 16 метрлік қадалар және қосымша 11,5 метрлік (9,5 м) қадалардың жалпы ұзындығы 25,5 м және 27,5 м, көлденең қимасы 40×40 см бар. Қадалардың іргетастарын жобалау нормативтік стандарттардың талаптарына сәйкес жүзеге асырылды. DLT сынау әдісі модульдік қадалардың жүк көтергіштігін бағалау үшін де қажет. Plaxis 2D бағдарламасында қадаларды сандық модельдеу жүргізілді. Батыс Қазақстанда орналасқан модульдік қадалардың және күрделі топырақ жағдайларынның арасында өзара әрекеттесу механизмі ұсынылған.*

***Кілт сөздер:** модулдік қадалар, жүктеме, отыруы, сынау, жүк көтергіштігі, статикалық сынағы, динамикалық сынағы, нормативтік стандарт, сандық модельдеу.*

Анализ комплексных испытаний модульных свай в сложных грунтовых условиях

*[1]**ОМАРОВ Абдулла Рахметович,** PhD, и.о. доцента, omarov_01@bk.ru,*
*[1]**ЖУСУПБЕКОВ Аскар Жагпарович,** д.т.н., профессор, astana-geostroi@mail.ru,*
*[1]***ТЛЕУЛЕНОВА Гульшат Толеувна,** PhD, и.о. доцента, gulshattleulenova23@mail.ru,*
*[2]**ОРАЗОВА Динара Казбековна,** PhD, ассоциированный профессор, dinarzhan_84@mail.ru,*
[1]НАО «Евразийский национальный университет имени Л.Н. Гумилева», Казахстан, Астана, ул. Сатпаева, 2,
[2]НАО «Торайгыров университет», Казахстан, Павлодар, ул. Ломова, 64,

**автор-корреспондент.*

***Аннотация.** Целью научной работы является сравнительный анализ с использованием методов статического испытания (SCLT) и динамического испытания на нагрузку (DLT) для определения несущей способности свайных фундаментов в сложных грунтовых условиях. Мегапроект – это строительная площадка по разгрузке грузов (COF) в Атырауской области. В проекте использованы 2-модульные сваи. Модульные сваи из сборного железобетона имеют 16-метровые сваи и 11,5-метровые (9,5 м) сваи со стыком общей длиной 25,5 м и 27,5 м, поперечным сечением 40×40 см. Проектирование свайных фундаментов было выполнено в соответствии с требованиями нормативных стандартов. Метод испытания DLT также необходим для оценки несущей способности модульных свай. Проведено численное моделирование свай в программе Plaxis 2D. Представлено взаимодействие модульных свай со сложными грунтовыми грунтами Западного Казахстана.*

***Ключевые слова:** модульная свая, нагрузка, осадка, испытания, несущая способность, статические испытания, динамические испытания, нормативный стандарт, численное моделирование.*

REFERENCES

1. Geotechnical Interpretation Report. Cargo. Project: WBCAS134-3.TN.028.F01, Atyrau, 2014. – 78 p.
2. Zhussupbekov, A.Zh., Omarov, A.R. Analysis of effect of pile driving on the existing foundation // Bulletin Construction and Architecture, Volume 7, 2016. – Pp. 132-138
3. Zhussupbekov, A.Zh., Lukpanov, R.E., Omarov, A.R. Experience in Applying Pile Static Testing Methods at the Expo 2017 Construction Site // Journal of Soil Mechanics and Foundation Engineering, Volume 53, Issue 4, 2016. – Pp. 251-256.
4. Zhussupbekov, A., Omarov, A., Yergen, A., Tleulenova, G., Borgekova K. Investigations of Interaction of Joint Piles with Problematical Soil Ground in Kazakhstan // Proceedings of Seventh International Conference – GeoMate 2017, Geotechnique, Construction materials and Environment, TSU, Mie, 2017. – Pp. 283-388.
5. Zhussupbekov, A., Shakhmov, Zh., Tleulenova, G. Application Static Load Test (SLT) and Pile Integrity Testing (PIT) of piles in sea port «Prorva» (West Kazakhstan) // Proceedings Fourth International Conference on Science, Engineering & Environment. – Nagoya, 2018. – Pp. 1129-1134.
6. SNIP RK 5.01-03-2002. Pile foundations, Almaty: KazGOR, 2003. – Pp. 27-29.
7. SNIP RK 5.01-01-2002. Foundations of buildings and structures, Almaty: KazGOR, 2003. – Pp. 18-22.
8. Zhussupbekov, A., Omarov, A. Modern Advances in the Field Geotechnical Testing Investigations of Pile Foundations // Procedia Engineering, Volume 165, 2016. – Pp. 88-95.