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Investigation of boring pile integrity of road systems in engineering-geological condition of Kazakhstan

Abstract. *The paper considers the testing of pile foundations for continuity at Atbasar pipeline facility. For testing monolithic concrete and reinforced concrete structures, a variety of the pit (pile integrity test) method is used – low-deformation dynamic tests. This is the most modern technique in the world practice of recent years. It allows you to check the continuity of all types of monolithic concrete and reinforced concrete structures, including concrete (reinforced concrete) piles, to identify defects in them. Based on the obtained pile data, as a result of testing for the continuity of foundations, the number of non-defective piles and defective piles are reflected, and solutions are proposed to ensure the reliability and safety of the pipeline operation. A total of 10 bored piles, which were located in 4 separately standing foundations, were investigated in the work. The results showed that 3 piles could have defects in the form of cracks or narrowing of the cross-section of the bored piles.*
Keywords: *pile tests, highway, overpass, defects*.

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Introduction

For many years scientists have been studying geotechnical problems associated with the railway [1]. Particularly important is the quality construction of elevated structures over railroads. It is very important in this case correctly and qualitatively build the foundations for these structures.

In Kazakhstan, the actual problem is the main track at the intersection of the railway with the highway, which lead to accidents and other risks.

The construction of overpasses serves not only for the safety and reliability of main roads, but also for the operation of communications.

Tests of piles integrity were carried out at the construction site is "Reconstruction of the Heat Supply Network Over the Railway Line in Atbasar" [2].

According to the geological conditions, the soils are weak. Bored piles were used in the project. 10 bored piles with a diameter of 300 mm were subjected to tests.

The purpose of the tests is to determine the depth of immersion of piles and to identify defects. Tests of piles for continuity were carried out in accordance with the requirements regulated by standard [3-4].

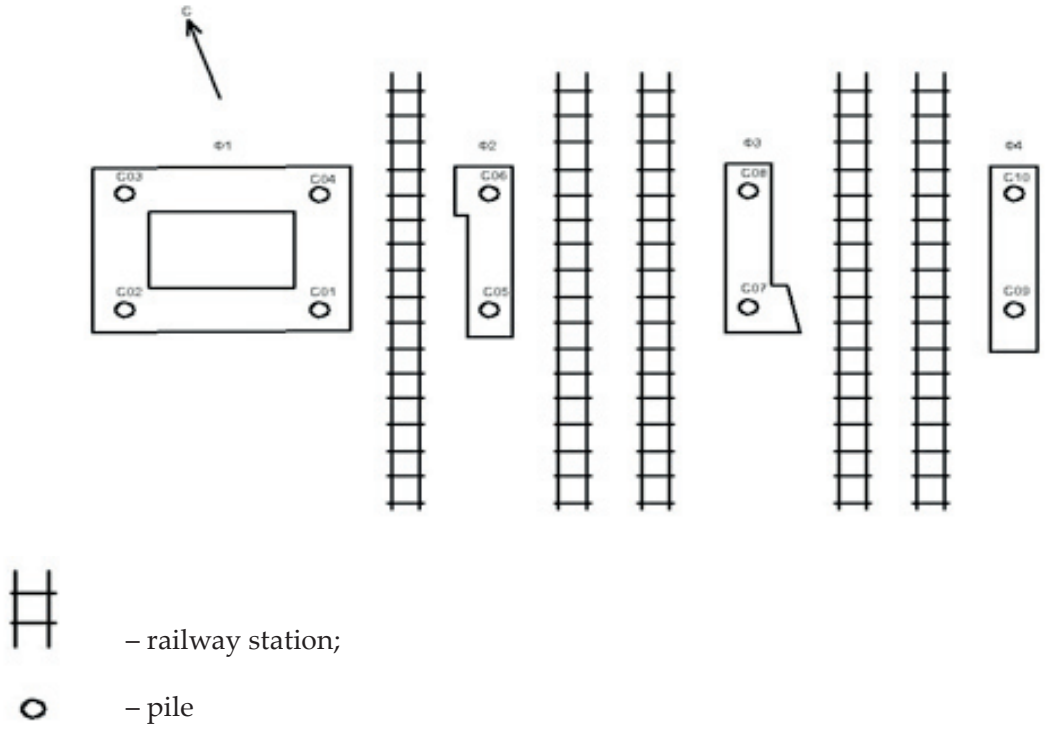
The work of checking of piles integrity by a non-destructive method is divided into two stages:

– testing of piles at the construction site;

– interpretation of the received information with the help of special software.

The pile tests were carried out on August 14, 2018. The outside air temperature at the time of the test was +30°C. Figures 1 and 2 illustrate the construction site.

Figure 1. General view of the construction site



– railway station;

– pile

Figure 2. General view of the site

Research methods

Pile test's is a user-friendly, highly flexible solution for testing a large number of deep foundations quickly and accurately [5–7].

The principle of this method is based on recording the parameters of elastic waves generated in the monitored objects (piles) by means of an impact pulse, transmitted to the pile face [8-9].

The method involves:

– performing a mechanical impact with a hammer, carried out in parallel to the longitudinal axis of the pile parallel to the longitudinal axis of the pile;

– measuring, by means of a sensor (accelerometer) mounted on top of the pile, the amplitude of the vibrating wave induced by the impact sensor (accelerometer) installed on top of the pile, measuring, through a sensor (accelerometer), the amplitude of the vibrating wave induced by the impact.

Calculation of the distance L from the point of reflection:

– either the duration of the reflected longitudinal wave from the time domain of the signal (1):

$$L = 0.5 \times C \times \Delta t \quad (1)$$

– or frequency deviation from the time of signal reception in the frequency domain (2):

$$L = 0.5 \times C/\Delta f \quad (2)$$

Requiring little-to-no training, PET is a modular, computer-independent system that connects to any compatible computer protocol.

The PET system utilizes the pulse-echo method [4, 5]. To test a pile, the use strikes it with PET's lightweight handheld hammer. The resulting signal, or reflectogram, is captured and transferred, providing real-time information about the length and shape of the pile (Fig. 3).

Figure 3. General view of the pile grillage

Results and discussion

The modulus of elasticity and concrete density for determining the wave velocity in the case of bored piles (and other types of piles installed in situ), it is recommended to use modulus and density values based on experimental studies (actual values at the time of testing) in accordance with the requirements of current regulations (fig. 4)

Figure 4. Testing procedure with PET

Install the sensor on the head of the pile, having previously placed a connecting element that promotes the propagation of mechanical waves. Make sure that external sources of vibration do not make additional measurements.

Make a hammer blow on the head of the pile parallel to the longitudinal axis. Visualize and register the signal. To obtain three signals suitable for processing in a similar way.

Table 1. Results of testing piles

№	Pile	Depth (m)	Remarks
1	C01	5.9	Crack or narrowing in cross section at a depth of 2.5 m
2	C02	5.6	No defects found
3	C03	4.7	No defects found
4	C04	6.6	No defects found
5	C05	6.1	Crack or narrowing in cross section at a depth of 3.3 m
6	C06	6.5	No defects found
7	C07	5.0	No defects found
8	C08	5.3	Crack or narrowing in cross section at a depth of 2.3 m
9	C09	3.7	No defects found
10	C10	3.4	No defects found

If piles that do not have access to the head need to create conditions for carrying out a blow parallel to the longitudinal axis of the pile in the following way: make a niche in the pile shaft and prepare a vertical surface sufficient for testing, but not less than 10x10x15 (width, length, height) (fig.5)

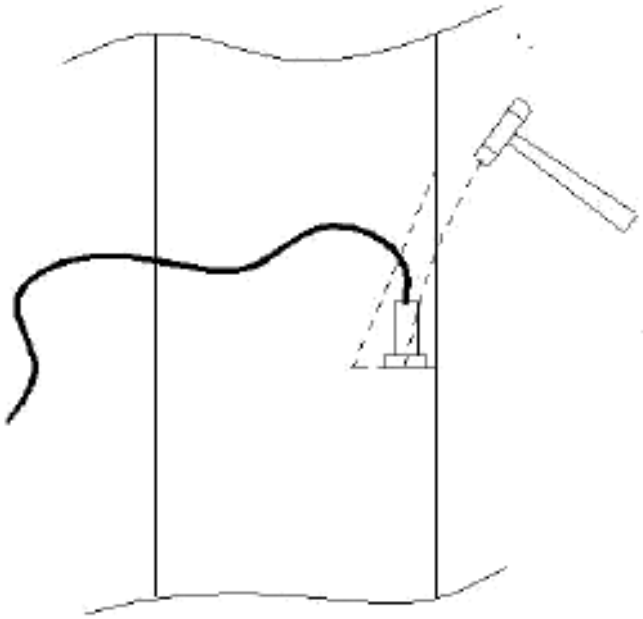


Figure 5. Vertical surface preparation

Conclusion

It can be noted that the continuity test is an important procedure for evaluating the quality of the foundation. The test itself is a check to determine the quality of the work to be done. Due to the results obtained it is possible to additionally recalculate and determine the final bearing capacity of the piles.

According to the results of these tests, the following is recommended:

If necessary, in agreement with the design organization, test piles (which showed a shorter length compared to the design one or turned out to be defective) to determine the actual bearing capacity;

For inspection of piles that do not have access to the head is recommended excavate the soil from the accessible side of the tested pile to a depth of 1-2m, depending on the depth of the tip immersion.

References

1. A railway accident prevention method based on reinforcement learning – Active preventive strategy by multi-modal data - ScienceDirect https://www.sciencedirect.com/science/article/abs/pii/S0951832023000510 (accessed: 03.2023)
2. Report of Atbasar city Highway – 2018.
3. Regulatory and technical manual RK 07-02.2-2011 Pile integrity testing. A.: Standards, 2015.
4. Features of the assessment of the continuity of piles by the method of seismoacoustic flaw detection [Text] / D.E. Nikolaevich, K.B. Sergeevich, B.D. Gennadievich // Construction: Science and education. – 2022. – № 1. – C. 49–60.

5. Pile integrity testing and analysis / F.R. Kung G. Likins, Shen Ren // Application of Stress-wave Theory to Piles Routledge, 1992.

6. Theoretical analysis of three-dimensional effect in pile integrity test [Text] / X. Liu, M. Hesham El Naggar, K. Wang, W. Wu // Computers and Geotechnics. – 2020. – Vol. 127. – P. 103765. https://doi.org/10.1016/j.compgeo.2020.103765

7. Analytical Study of Employing Low-Strain Lateral Pile Integrity Test on a Defective Extended Pile Shaft [Text] / J. Wu, M.H. El Naggar, K. Wang, X. Liu // Journal of Engineering Mechanics. – 2020. – Vol. 146, No. 9. – P. 04020103. https://doi.org/10.1061/(ASCE)EM.1943-7889.0001841

8. G. Likins and F. Rausche. Recent advances and proper use of PDI low straing pile integrity testing // Proceedings of the 6th International Conference on the Application of Stress- Wave Theory to Piles.- Sao Paulo, Brazil, 2000. - p. 211-218

9. Effects of the Source on Wave Propagation in Pile Integrity Testing | Journal of Geotechnical and Geoenvironmental Engineering | Vol 136, No 9 [Electronic resource] https://ascelibrary.org/doi/abs/10.1061/(ASCE)GT.1943-5606.0000272 (accessed: 03.2023)

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Қазақстанның инженерлік-геологиялық жағдайларында жол жүйелеріне арналған бұрулған қадаларды зерттеу

Аңдатпа. Мақалада Атбасардағы құбыр объектісіндегі сабақтастық үшін қадалардың іргетастарын сынау қарастырылады.

Монолитті бетон және темірбетон конструкцияларын сынау үшін шұңқыр әдісінің бір түрі қолданылады (қадалардың тұтастығын тексеру) – деформациясы төмен динамикалық сынақтар.

Бұл соңғы жылдардағы әлемдік тәжірибедегі ең заманауи әдіс. Ол монолитті бетон және темірбетон конструкцияларының барлық түрлерінің, соның ішінде бетон (темірбетон) қадалардың тұтастығын тексеруге, олардағы ақауларды анықтауға мүмкіндік береді.

Қадалар туралы алынған мәліметтер негізінде іргетастардың үздіксіздігіне тестілеу нәтижесінде ақаулы қадалар мен ақаулы қадалардың саны көрсетіледі және құбырды пайдаланудың сенімділігі мен қауіпсіздігін қамтамасыз ету үшін шешімдер ұсынылады.

Түйін сөздер: тестілер, эстакада, деформация, дефектілер.

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Исследование буронабивных свай на сплошность дорожных систем в инженерно-геологических условиях Казахстана

Аннотация. В статье рассматривается испытание свайных фундаментов сплошности на трубопроводной магистрали в г. Атбасар.

Для испытания монолитных бетонных и железобетонных конструкций используется разновидность метода котлована (проверка целостности свай) – динамические испытания с низкой деформацией.

Это самая современная методика в мировой практике последних лет. Она позволяет проверить целостность всех типов монолитных бетонных и железобетонных конструкций, включая бетонные (железобетонные) сваи, выявить в них дефекты.

На основании полученных данных о сваях, в результате тестирования на непрерывность фундаментов отражается количество бездефектных свай и дефектных свай и предлагаются решения для обеспечения надежности и безопасности эксплуатации трубопровода.

Ключевые слова: тесты, эстакада, деформация, дефекты.

References

1. A railway accident prevention method based on reinforcement learning – Active preventive strategy by multi-modal data – ScienceDirect https://www.sciencedirect.com/science/article/abs/pii/S0951832023000510 (accessed: 03.2023)

2. Atbasar k. magistral' turaly esebi – 2018.

3. Normativno-tekhnicheskoe posobie RK 07-02.2-2011 Pile integrity testing. A.: Standards, 2015.

4. Osobennosti ocenki sploshnosti svaj metodom sejsmoakusticheskoj defektoskopii [Text] / D.E. Nikolaevich, K.B. Sergeevich, B.D. Gennadievich // Stroitel'stvo: nauka i obrazovanie. – 2022. – № 1. – C. 49–60.

5. Pile integrity testing and analysis / F.R. Kung G. Likins, Shen Ren // Application of Stress-wave Theory to Piles Routledge, 1992.

6. Theoretical analysis of three-dimensional effect in pile integrity test [Text] / X. Liu, M. Hesham El Naggar, K. Wang, W. Wu // Computers and Geotechnics. – 2020. – Vol. 127. – P. 103765. https://doi.org/10.1016/j.compgeo.2020.103765

7. Analytical Study of Employing Low-Strain Lateral Pile Integrity Test on a Defective Extended Pile Shaft [Text] / J. Wu, M.H. El Naggar, K. Wang, X. Liu // Journal of Engineering Mechanics. – 2020. – Vol. 146, No. 9. – P. 04020103. https://doi.org/10.1061/(ASCE)EM.1943-7889.0001841

8. G. Likins and F. Rausche. Recent advances and proper use of PDI low straing pile integrity testing // Proceedings of the 6th International Conference on the Application of Stress- Wave Theory to Piles.- Sao Paulo, Brazil, 2000. - p. 211-218

9. Effects of the Source on Wave Propagation in Pile Integrity Testing | Journal of Geotechnical and Geoenvironmental Engineering | Vol 136, No 9 [Electronic resource] https://ascelibrary.org/doi/abs/10.1061/(ASCE)GT.1943-5606.0000272 (accessed: 03.2023)

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