 **COMPANY TEMIRALI LTD**

**PROCEDURE**

**FOR PILE INTEGRITY TEST BY**

**REFLECTED WAVE METHOD –Sonic integrity testing**

**(ATYRAU, TENGIZ)**

**REPUBLIC OF KAZAKHSTAN**

|  |  |  |  |
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“\_\_\_\_\_\_”\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_2012

**REPORT**

**FOR RESULTS OF PILE TESTING FOR INTEGRITY**

**AT CONSTRUCTION UNIT OF PROJECT**

**WISU /WATER INJECTION SYSTEM UPGRADE**

**(ATYRAU, TENGIZ)**

**REPUBLIC OF KAZAKHSTAN**

**Atyrau, 2012**

“KGS”LTD

Limited Trusted Company

Pile works, pile testing, pile testing for integrity,

geotechnical control, complex reconstruction,

projection, estimation of accuracy of building

and structures

**ENGINEERING CONCLUSION**

**For results of driven piles test , fabricated at the construction area of Project**

**WISU /Water Injection System Upgrade**

**(Aturay, Tengiz)**

**Republic of Kazakhstan**

File Footage Number: 64212

**Atyrau 2012**

Contents

INTRODUCTION………………………………………………………………...5

1. GENERAL INFORMATION (tasks, test stages, technology of pile arrangement, area conditions description )………………………………….…………….…5
2. GENERAL METHODS OF PILE INTEGRITY BY REFLECTED WAVE

METHOD……………………………………………...………………………….5

1. PILE TEST RESULTS AND CONCLUSIONS ………………..……11

ATTACHMENTS:

Attachement1 Pile test results ( test acts, tested piles reflectograms, pile test logs for integrity……………………………………………………………………………12

Log of Pile test for integrity………………………………………..13

Act of Pile test for integrity………………………………………………….14-18

INTRODUCTION

This Conclusion had been wrote on 17, September, 2012 according to the test results of 5 driven piles fabricated at construction area “ Water reutilization of WTC of TCO” (Atyrau, Tengiz)

The purpose of test is checking of integrity of process piles’ bodies after driving.

During testing the next work package was made:

* low-deformative dynamic pile test;
* analysis of test results and compounding of conclisions.

Testing engineer, PhD Lukpanov took part in this job

Testing engineer, PhD\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Lukpanov R.E.

1. GENERAL INFORMATION

Construction area “ Water reutilization of WTC of TCO” is located in Tengiz< Aturay Region, Republic of Kazakhstan

Driving in of process piles with the cross section 30x30 sm, with length 12m ( which were drove on soil 9,5 m deep at construction area was made by drive plant SP-76A.

Totally it was tested 5 driven pile , it is equal 6% from total quantity of process piles , and it is enough for writing of this conclusion

Testing was performed by-stage, in depend of work execution schedule. It is necessary to note that the period of carrying out of test was not less than 6 days sinve day of driving in and it is corresponded to Time Standard of Republic of Kazakhstan.

1. **GENERAL METHODS OF PILE INTEGRITY BY REFLECTED WAVE METHOD**

For pile testing the variety of Method FPDS (Foundation Pile Diagnostic System Sonic Integrity Testing) is used, it is a low-deformative dynamic pile test.

It is the most modern method in world practice for last years. It permits to check the integrity of performance o all kind of piles and also to reveal the defects inside the piles.

There are some types of low-deformative tests, such as ultrasound test, frequency test, echo test, etc

**Ultrasound test**

According to this method it is made the strike against crown of pile by light-weight special hammer and the response for this strike is measured by sensor. The ruptures and the compactions of cross section make the reflection which change the signal format. The signal is interpreted according to these changes. The main defects with indication of depth of it’s location are identified.

**Frequency analysis**

For this method it is necessary to strike against pile head by special tool hammer . The audio frequencies of response are checked by making of resonance peaks, which are used for identification of main defects. This method gives a possibility to identify the integrity of crown of pile.

In all these methods not only the pile geometry and its ruptures affected to the signals but also the characteristics of soil which can make the signal wrong . Thereby , the interpretation of signal must be made by special trained and experienced operator, who must have all information about pile and geology of area.

In spite of others kinds of integrity tests the low-deformative test is NDT inspection (nondestructive testing) which does not require the special preparing during or after pile installation; it is necessary to have the sound conductivity crown of pile for making of strike by hammer and for affixing of sensor.

Low-deformative tests can be used to driven , drilled, drilled- injectioned, wooden and steel piles, but the prevalent cases of tests are made for driven and drilled piles.

**The requirements for test**

For receipt of high-quality signal for ne[t interpretation it is necessary t:

1. The pile must be clean to sound-conducting material, it must be free from soft concrete, cracks and exfoliation.
2. The surface must be free from water
3. Any structures or components must be fixed to pile, because greatly prominent reinforcement or frame can return the signals, which will be impossible to interpret. In the most often cases the influence of these elements is filtered by device.
4. The access to crown of pile must permit putting of some strikes by hammer and must assure the space for installation of sensors.
5. Moist concrete is not acceptable to test. It is necessary for dilled piles to stay the period from 7 to 30 days for increase of strength needed for test.
6. For reliability and receipt of acceptable signal it is necessary to make some strikes against crown of pile
7. It is advisable to give “relax” for driven piles before tests.

**Procedure of test.**

1. Cleaning of crown of pile from soil, snow, ice to surface of concrete of crown of pile. Preparation of 3 points smooth concrete dry areas on crown of pile ( if it is possible) , the sizes of areas are 100x100mm approximate for installation of sensors and for strike against concrete surface of pile by special hammer.
2. The next characteristics are brought to device’s memory: name of area, number of pile, length, speed of wave propagation in concrete.
3. The sensor which make the registration of reflected signals is installed on the prepared area on crown of pile through special paste for better registration of signal. The slack strike are made by special hammer against crown of pile on the prepared area. After every strike on device’s monitor the diagram (reflectogram) of dependence of amplitude of strike against pile length is appeared. If the operator identifies these diagrams as acceptable than the result is wrote to the memory for the next handling. If the strike is too weak or too strong the device does not register the signal and it is necessary to repeat the strike. The strikes are made till the operator can interpret the often repeat diagram
4. After completion of test all data of integrity pile test are processed by special program and the results are output in the form of diagram “signal amplitude”-“pile length”. According to this diagram operator classifies the piles regarding their product quality.
5. Intermediate result is given to Client after date processing and it is given during the shortest terms as it is possible.
6. The final report for pile integrity test is given to Client after completion of all series of test with the detailed analysis.

Please see the Fugure 1 on next page



Signal frequency analysis

Signal timing analysis

measuring instrument

receiving device (speed detector or accelerometer)

Concrete pile

Vibrate wave

Soil

Hammer

**Fugure1. Test Procedure:** During pile test it isstriking against crown of pile by hand-held hammer which send strained wave by down on the pile surface.Return wave show the pile granularity and pile bottom. Sensitive accelerator installed oncrown of pile measures the shift of crown of pile which was provoked by stress wave by hummer strike and following reflections. The signal is converted to the velocity and it is offered on the screen as a time function . After this all results keep on computer for following of signal processing. Time from the strike to return of wave describes the pile length and it’s mechanical characteristic **T=2L/C**, where T is the time from strike to return, L is the pile length, C – the speed of wave transmission(c**=**), where E is the absolute value of , flexibility, ρ is density of concrete.The speed of wave transmission in concrete can fluctuate from 3200 to 4400 m/sec in depend of period of concreting, the concrete quality and other factors. The average speed of wave transmission in concrete with Grade B20-25 is 3600 m/sec.

The accuracy of determination of pile length depends from the accuracy of speed of stressed wave. When the pile length is known than velocity of wave propagation can be adopt to known length.

**2.3. The explanation of diagram**



pile 9D-number of pile

SiteCaseB4- name of area

Vel=4100m/s-velocity of of wave propagation in concrete

7.6(mm/s)- the impact force

f- adjustment of device for filter of signal

exp- constant of device for adjustment of amplitude of diagram

sr V7.0- constant of type of signal correction

19.5 (m)- measured pile length

Figure 2- The examples of pile without defects and pile with defect. Pile 34 is without defect, pile3 has a big crack on the depth 2.7m

The graphic interpretation:

1. If the diagram has sharp distinct vibration with the subsequent reflection of signal we can tell that it is shown to us broadening or narrowing, presence of foreign bodies, concrete disintegration, crack of influence of geology. The correct interpretation can be made also by operator.
2. If curved line has little vibration than we can tell that this pile has no defects
3. If curved line has high smooth jump up and then down with subsequent repetition of signal than pile has broadening on this part. If diagram has smooth high jump down, and then up with subsequent repetition of signal then pile has narrow spot, influence of geological conditions (mellow soil filled by water), change of consistency of the soil or consistency of the concrete
4. If diagram has sharp vibrations and there is no possibility to determine the end of pile then the pile has grave crack or narrow spot on the place of beginnibg of vibration.

**2.5. Advantages, limitations and possibilities of low-deformative tests**

**Advantages**

* The equipment is mobile and easy to carry to other place. One operator can test about 100 piles per day, depend from conditions of area, pile preparation and access to pile
* Minimal interference to construction works at site
* Defects can be determined on initial stage

**Limitations**

* Reflection of bottomhole can be given not every time in depend of conditions of soil
* Low vibrations of pile cross-section(less than5%) can not be determined

**Possibilities**

Low-deformative tests allow to determine:

* Reflection of bottomhole
* Reflection from substantial inclusion of materials, having the different acoustical properties
* Reflection from existing crashes and spallings
* Reflection from broadening of cross section
* Reflection from narrowing of cross section
* Reflection from change of soil characteristics
* Reflection from change of material

Low-deformative tests does not allow to determine:

* progressive broadening of cross section
* progressive narrowing of cross section
* bent shape
* small inclusion of foreign material
* debris in end of pile bottom
* Crashes which are located in parallel with line of pile center



**Fugure3 Examples of defective piles**

1. **Pile test results and conclusions**

Pile test includes as minimum 3 tests for each pile and processing of results by computer by special program PDI (USA).During processing of results it was supposed the pile concrete has project grade for compressive resistance. Received diagrams of integrity can be accepted as interpreted, without faults.

According to results od test of 5 process piles ( see Attachment) passed on 17, September, 2012 at construction area “ Water reutilization of WTC of TCO” (Atyrau, Tengiz) it can be made the conclusion that integrity of tested pile are ensured, there are no any pile defects ( see test log)

Testing engineer, “KGS” Ltd\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Lukpanov R.E.

**ATTACHMENTS**

**Attachment 1**

**Log of Pile test for integrity**

**Acts of Pile test for integrity**

**Reflectograms of Pile test for integrity**

**Table of test results**

**Layout chart of pile which were tested for integrity**

**“KGS”LTD**

**Log of Pile test for integrity**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Unit: WISU /Water Injection System Upgrade**  **(Aturay, Tengiz)** | | | | Test Date:  17, September, 2012 |
| № of item | Number of pile | | Test result | Comment |
| 1 | | TC1 | See the diagram | **There are no any defects** |
| 2 | | TC2 | See the diagram | **There are no any defects** |
| 3 | | TC3 | See the diagram | **There are no any defects** |
| 4 | | TC4 | See the diagram | **There are no any defects** |
| 5 | | TC5 | See the diagram | **There are no any defects** |
|  | | PREPERED BY: | | ACCEPTED BY: |
| Position: | | Testing engineer, “KGS” Ltd | |  |
| Signature: | |  | |  |
| Surname: | | Lukpanov R.E | |  |
| Date | | 17.09.2012 | |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **“KGS” Ltd** | | | | | **Act of Pile test for integrity**  **Reflected wave method** | | | |
| **WISU /WATER INJECTION SYSTEM UPGRADE** | | | | | | **Pile Number: №TC1** | | |
| Pile  **Surveying reference**  **marks** | |  | | | | **Test date: 17.09.12** | | |
| **Pile type**  X  Driven  Drilled | | | | Surveying reference  marks | | Zt=  Zb=  ZN= |
| **Reference to working drawing**  **X-800-058-08**  **Lay out of pile area** | | | | Instrumentation  **Device: PitW**  **Calibration date: 28.01.2010** | | |
| **Comments:**  There are no any defects | | | | | | |
| **Pile characteristics** | D=12,0m  B=0,3m | The necessity of additional analysis:  YES No  X | | | | | | |
|  | | | | | | | | |
| Measured length=9,6 m  With C=4000m/s | | | | Responsible for test execution is Lukpanov R.E  Date is 18.09.12  Signature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | |
|  | | | FILL OUT BY: | | | | ACCEPTED BY: | |
| Position: | | | Testing engineer, “KGS” Ltd | | | |  | |
| Signature: | | |  | | | |  | |
| Surname: | | | Lukpanov R.E | | | |  | |
| Date | | | 17.09.2012 | | | |  | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **“KGS” Ltd** | | | | | **Act of Pile test for integrity**  **Reflected wave method** | | | |
| **WISU /WATER INJECTION SYSTEM UPGRADE** | | | | | | **Pile Number: №TC1** | | |
| Pile  **Surveying reference**  **marks** | |  | | | | **Test date: 17.09.12** | | |
| **Pile type**  Driven  X X  Drilled | | | | Surveying reference  marks | | Zt=  Zb=  ZN= |
| **Reference to working drawing**  **X-800-058-08**  **Lay out of pile area** | | | | Instrumentation  **Device: PitW**  **Calibration date: 28.01.2010** | | |
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| **Pile characteristics** | D=12,0m  B=0,3m | The necessity of additional analysis:  X  YES No | | | | | | |
|  | | | | | | | | |
| Measured length=9,7 m  With C=4000m/s | | | | Responsible for test execution is Lukpanov R.E  Date is 18.09.12  Signature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | |
|  | | | FILL OUT BY: | | | | ACCEPTED BY: | |
| Position: | | | Testing engineer, “KGS” Ltd | | | |  | |
| Signature: | | |  | | | |  | |
| Surname: | | | Lukpanov R.E | | | |  | |
| Date | | | 17.09.2012 | | | |  | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **“KGS” Ltd** | | | | | **Act of Pile test for integrity**  **Reflected wave method** | | | |
| **WISU /WATER INJECTION SYSTEM UPGRADE** | | | | | | **Pile Number: №TC1** | | |
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| **Reference to working drawing**  **X-800-058-08**  **Lay out of pile area** | | | | Instrumentation  **Device: PitW**  **Calibration date: 28.01.2010** | | |
| **Comments:**  There are no any defects | | | | | | |
| **Pile characteristics** | D=12,0m  B=0,3m | The necessity of additional analyses:  X  YES No | | | | | | |
| Analysis of wave passing to pile body | | | | | | | | |
| Measured length=9,7 m  With C=4000m/s | | | | Responsible for test execution is Lukpanov R.E  Date is 18.09.12  Signature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | |
|  | | | FILL OUT BY: | | | | ACCEPTED BY: | |
| Position: | | | Testing engineer, “KGS” Ltd | | | |  | |
| Signature: | | |  | | | |  | |
| Surname: | | | Lukpanov R.E | | | |  | |
| Date | | | 17.09.2012 | | | |  | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **“KGS” Ltd** | | | | | **Act of Pile test for integrity**  **Reflected wave method** | | | |
| **WISU /WATER INJECTION SYSTEM UPGRADE** | | | | | | **Pile Number: №TC1** | | |
| Pile  **Surveying reference**  **marks** | |  | | | | **Test date: 17.09.12** | | |
| **Pile type**  Driven  X  Drilled | | | | Surveying reference  marks | | Zt=  Zb=  ZN= |
| **Reference to working drawing**  **X-800-058-08**  **Lay out of pile area** | | | | Instrumentation  **Device: PitW**  **Calibration date: 28.01.2010** | | |
| **Comments:**  There are no any defects | | | | | | |
| **Pile characteristics** | D=12,0m  B=0,3m | The necessity of additional analysis:  X  YES No | | | | | | |
| Analysis of wave passing to pile body | | | | | | | | |
| Measured length=9,7 m  With C=4000m/s | | | | Responsible for test execution is Lukpanov R.E  Date is 18.09.12  Signature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | |
|  | | | FILL OUT BY: | | | | ACCEPTED BY: | |
| Position: | | | Testing engineer, “KGS” Ltd | | | |  | |
| Signature: | | |  | | | |  | |
| Surname: | | | Lukpanov R.E | | | |  | |
| Date | | | 17.09.2012 | | | |  | |

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| **“KGS” Ltd** | | | | | **Act of Pile test for integrity**  **Reflected wave method** | | | |
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|  | | | FILL OUT BY: | | | | ACCEPTED BY: | |
| Position: | | | Testing engineer, “KGS” Ltd | | | |  | |
| Signature: | | |  | | | |  | |
| Surname: | | | Lukpanov R.E | | | |  | |
| Date | | | 17.09.2012 | | | |  | |