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ScienceDirect

Procedia Engineering 111 (2015) 652 – 655

Procedia Engineering

www.elsevier.com/locate/procedia

XXIV R-S-P seminar, Theoretical Foundation of Civil Engineering (24RSP) (TFoCE 2015)

On technology of hydraulic engineering structures pile foundations production

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Abstract

The paper presents aims to provide analysis of non-waste technology of producing piled foundations of hydraulic engineering structures. The authors introduce a complexity of additional technical and technological steps making possible to both diminish the work-load and cut the time required. The paper also describes main stages of the work and points out the main drawbacks of the traditional technology. The authors prove that on condition of proper technique training and experience it is possible to design and produce pile fields characterized by minimal materials consumption thus saving 10-15% of zero circle estimated cost and cutting the time required for construction.

Peer-review under responsibility of organizing committee of the XXIV R-S-P seminar, Theoretical Foundation of Civil Engineering (24RSP)

Keywords: Piled foundations; Pile characteristics; Bearing capability; Geotechnical survey.

1. Introduction

Piling is widely used at hydraulic engineering facilities, not only during construction of buildings and structures, but also in ground stabilization. The scope of piling work at large hydraulic energy facilities often means hundreds of thousands of driven piles or piles produced on the site. Having analyzed the practice of erecting hydrostatic facilities, we have come to conclusion that material and human resources are used inefficiently. There are also reserves of pile bearing capacity, the value of which is much higher than the required one. Thus, the paper is aimed

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Peer-review under responsibility of organizing committee of the XXIV R-S-P seminar, Theoretical Foundation of Civil Engineering (24RSP)
doi:10.1016/j.proeng.2015.07.127

at reducing capital invested into production of pile fields; supporting designed values for load-bearing capacity. As a solution we recommend to use non-waste technology of producing piled foundations.

2. Research

The proposed non-waste technology of producing pile foundations is based on a complexity of additional technical and technological steps making possible to both diminish the work-load and cut the time required.

The proposed set of works includes the following steps:

- Analysis and improvement of the project documentation on the basis of additional engineering and geological surveys;
- Design improvement of piles used at construction sites and quality control of their production;
- Improvement of work performance technology and quality control of production.

Analysis of project documentation focuses on engineering and geological surveys of construction sites, their depth and accuracy of work. The previous experience has proved that the transition time of using non-waste technology of producing pile foundations needs more surveys than exist according to normative documents. This is due to the necessity of zoning the area along the pile length, as well as severe geological conditions in case of complex ground formations with different physical and mechanical properties. In addition, there is one more factor and it is the admeasurement of pile length based on the worst properties of the ground, which increases the cost of construction process because of insufficient experience in the design of pile structures.

Particular attention in the analysis of project documentation should be paid to technical project documentation. Based on the experience in this sphere, we have come to conclusion that many technological solutions for pile foundations need to be corrected, because of lack of information available in a design organization. Design organization quite rarely employ professionals with experience in designing piling technology who have information about the real situation with the fleet of construction machinery and mechanisms and who have the right level of qualified workers and engineering and technical personnel involved in the production. In this case there are two possibilities. The first option is to create a group which will include highly qualified external specialists. The special assignment of this group will be to develop projects for production of piling works. The second option is to hire an external design organization experienced in implementation of non-waste technology of producing pile foundations for project development.

Each of the above options will need additional surveys to revise the properties of ground at a construction site. In this context operating methods, such as static and dynamic sounding, are relevant. These research methods will specify the bearing capacity in some parts of the development area, help to carry out zoning of piles' length and will not require significant time and material costs.

To implement non-waste technology of pile foundations it is necessary to improve pile engineering design and quality control of pile production especially when piles are delivered to a construction site. The progressive design of piles must be specified at the project stage, taking into account the number of structural properties and characteristics: the ease of manufacturing and laying, perfect structures of butt joints [1, 5, 6, 9, 11, 12], over shock resistance (in case of driven piles). On-receipt quality inspection of piles, delivered at a construction site is of great importance too, especially when working on heavy grounds with significant resistance to pile driving [7, 8, 10, 15-19]. This fact is conditioned by characteristics of pile production and shipment from plants and landfills. Handling strength of a shipped pile structure is at least 70% of the project one. However, this strength may be insufficient for driving piles into heavy grounds, as it can result in deformation of piles. During the process of pile laying there are significant dynamic loads. In case of handling strength insufficiency for their load accommodation the result will be a pile fracture or a pile head split. In each of these cases it will be necessary to drive duplicate piles.

The most optimal solution of this situation is on-receipt inspection of concrete strength of piles delivered to a site. It allows sorting out piles according to their strength into piles with design strength and piles with less strength. It is also very practical to organize a warehouse at a construction site for storage of piles, which do not have the design strength, when a lot of piling work is intended. The use of a warehouse can result in the process when piles with strength less than the design one will gain strength with time and can be used in the construction industry. Thus it is possible to emphasize a substantial economic effect due to transport costs reduction and use of duplicate piles.

Preparation and implementation work on producing pile foundations is the final step of implementing non-waste technology. Analyzing the described process we can identify the main important aspects of its production. Firstly, pile driving below the design level and ensuring a given bearing capacity. Secondly, minimization of production time is of great importance. Thirdly, quality of preparatory work, including thorough geodesic preparation of a pile field with reliable fastening of pile driving points, specification and marking of stockpiling places and location of routes used for pile driving machines. Besides, pile-driving equipment is prepared, including measurement of blow energy on special stands, debugging of machinery [2].

Quality control of pile laying process is an important operation that means the operational measurement of technological parameters of the process. The most simple and at the same time reliable way to monitor bearing capacity is to count the number of blows sufficient to ensure the bearing capacity of a pile. That is how it is done in practice. In the process of production, a pile field is divided into sections according to the length of driven piles. A pile is driven in each section and it becomes the control indicator for bearing capacity. Either static or dynamic tests will be carried out for that. Driving of a test pile helps to measure the number of blows needed to lay a pile below the design level and ensure its bearing capacity. The measured number of blows is the main parameter for conducting control during the mass driving of a pile field. To implement this method it is recommended to use in practice an acoustic counter of blows.

It should be noted that one of the main advantages of non-waste technology of producing pile foundations is to provide the project marks that show the level of pile heads' driving. As a result there is no need for such a technological operation as pile trimming, which helps to economize time and materials because of saving those parts of pile heads, which usually go to waste [3, 7, 10].

The proposed technology of producing pile foundations of hydraulic engineering structures results in reliability of pile foundations in accordance with modern requirements, adopted in hydraulic engineering [4, 5, 6, 9, 11, 12]. When using non-waste technology it is possible to save about 10-15% of zero circle estimated cost due to significant cutting of time required for construction.

3. Conclusions

The experience of implementing non-waste technology of producing pile foundations of hydraulic engineering structures allows to ensure the designed bearing capability and significant saving of time and material resources at the same time. The degradation of characteristics responsible for the reliability of buildings and structures design is not observed.

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