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On technology of hydraulic engineering structures retaining walls production

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Abstract

The paper describes the design solution and technology of building retaining walls which belong to a kind of slurry-type wall. Bore pile are used in both the construction designed by the authors and in a slurry-type wall though the difference is that the new technology suggests using recycled steel pipes with timber plates between them. The most important characteristic feature of this retaining wall is that it can resist lateral loading made by ground coats, foundation pit, and all those building and constructions around it. It is easily possible to make such a construction a permanent one.

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Keywords: Retaining wall; Steel pipe; Timber boarding; Well boring; Concrete pouring.

1. Introduction

Erection of hydraulic engineering facilities requires stability of building walls during different periods of construction work. Such facilities include canal locks, vertical walls of canals and many others. There are some periods of construction: the period of facility erection and the time of its operation activity. This problem is even more challenging for reconstruction of the above mentioned facilities, especially in case of densely built-up area or when it is necessary to construct additional buildings or structures on developed areas and locate them near existing buildings and structures. In this case the construction of retaining walls is obligatory. However, labor and money

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costs of their construction are very high and at times can reach tens of percent of costs spent for a building itself. It is also possible to use a slurry-type wall which is a highly effective structure.

But in the above mentioned cases is not always possible to do that and it requires high production standards and specific equipment. As a result, more common options are usually used. Our option implies the use of retaining walls of different constructive solutions. Research of widely used modern constructions of retaining walls [1-4, 8, 9, 12, 14, 15] has proved that in some cases consumption of materials for their production is significantly increased as well as costs, so they are very expensive. Moreover these parameters are maximizing proportionally to their height increase.

2. Research

The paper presents the description of design solutions and technology of producing retaining walls. The proposed design shows a kind of slurry-type wall, however, in this case it is produced with the help of recycled steel pipes with timber plates. Bore piles are used in both the construction designed by the authors and in a slurry-type wall.

The designed retaining wall consists of steel pipes and timber plates. Steel pipes are installed at a certain calculated distance from each other, and between them a timber plate is fixed. It is made of boards as thick as 40-50mm. A special feature is the use of steel pipes to be recycled, that are wastes of oil or gas industries. But it is necessary to prepare the pipes in a specified way.

During the development of the project documentation the following parameters are calculated: diameter, thickness and length of retaining walls' tubular elements, as well as their spacing and the required thickness of a wooden plate. All these indicators are influenced by geological engineering conditions of the construction site, the depth of a foundation pit and the availability of construction equipment in a building company performing the task. Simultaneously project development works on carrying out the operations described above are conducted.

However, there must be performed some preliminary work, in particular, recycled steel pipes should be prepared for placing. The scope of this work includes a perforation device, which makes rectangular holes sized 100x150mm by gas cutting. Holes are supposed to be arranged in checkerboard pattern at 1000mm space. The main purpose of perforation is to increase the stability of a slurry-type wall, which is necessary for its further exploitation. After filling the pipes with concrete, it penetrates through perforation holes into the ground, and thereby utilizes the ground. In addition, steel corners with holes are welded along the pipe length on both sides, later they are used for fastening timber plate boards. To prepare a construction site for erecting retaining walls the following operations are performed: clearing and land planning to ensure the stability of boring tools, accessibility of concrete mixer trucks and installation of concrete pumps.

Technology of building retaining walls is applied in the following technological sequence. Along the perimeter of the designed pit in accordance with the project boreholes of given diameter and depth are drilled. For this type of work industrial, series-produced, self-propelled rigs are used. Depending on the stability of ground walls the boring technology can be of two types: "dry" or "wet." The "wet" method ensures the stability of boreholes' walls by pumping into a borehole the drilling (thixotropic) mud. To avoid or prevent the bridgeover, the process of boring is performed through a single borehole. Steel perforated pipes are laid with the help of mobile cranes in boreholes, but this work is carried out not later than 12 hours after completion of boring.

The next step of building a retaining wall is when laid pipes are covered with concrete. Flow concrete with medium workability of at least 18cm is used for that. Delivery of concrete to a construction site, as a rule, is done by mixer trucks. And its supply to the place of pouring (in the pipe of a retaining wall) is made with a mobile concrete pump with placer mast. The use of flow concrete is necessary to overcome technological limits such as vibration compaction. Medium workability of flow concrete is due to plasticizing chemical admixtures of "super plasticizer" class. The required class of concrete is determined by calculation, but it is often not less than B15. During the process of concrete pouring (filling the pipes with concrete), it penetrates through perforation holes into the ground. Later on concrete, depending on the consistency of the ground, penetrates into it at some distance from the surface of a pipe and, thus creates a concrete body. As a result the ground around the pipe is utilized for the joint work and gives additional stability to the construction of a retaining wall.

The layer-by-layer excavation of a foundation pit and installation of timber elements of plates is done after concrete gains the design strength. The thickness of each layer must be no more than 1.0m. Areas adjacent to the

pipes are usually excavated manually. Elements of timber plates are installed in each layer, plates are fixed to the corners, welded to pipes beforehand with the help of self-tapping screws. After excavation of a foundation pit as deep as the designed marks show either the construction of the substructure of a building or a structure, or erection of walls and bottom of canals or locks begin.

The most important characteristic feature of a retaining wall is that it can resist lateral loading made by ground coats, foundation pit, and all those building and constructions around it. The proposed technology allows to design and build foundations with a significant reduction in materials, labor and time costs. In addition, it is easily possible to make such a construction a permanent one. This wall structural design can also be used as a wall formwork element. It is possible to install reinforcement cages along it. As a rule, the minimum reinforcement is applied, followed by placing the second layer of a formwork and pouring of concrete mixture.

The practical use of this design of a retaining wall at both industrial civil and hydraulic engineering structures has shown high efficiency of its application due to large load-carrying capacity, simplicity and technological effectiveness of this device, use of rather cheap and widespread machinery owned by construction companies, use of cheap recycled pipes purchased at a scrap metal price. Characteristics of the proposed design of a wall meets the criteria for hydraulic structures [5, 6, 10, 11, 13, 18-24]. However, this structure is effective not only in terms of technology. Environmental issues can be also considered as amount of excavation work is reduced, thus reducing the amount of dumps, and there is a possibility of using such processed materials as recycled steel pipes.

3. Conclusions

Considering the above aspects we have come to the conclusion about the effectiveness of the proposed design, its low cost and time consuming due to a number of factors. The practical implementation of the proposed construction of a retaining wall does not require the use of expensive materials and specialized power-intensive machinery. The main bearing elements are steel pipes, recycled wastes of oil or gas industries.

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