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Case Report

Technology for Increasing the Reliability of Retaining Walls

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ABSTRACT

In modern geotechnical construction, increasing the bearing capacity of the bases is always a pressing issue. The employment of established solutions to ensure the sustainability of current restrictions is not always justified with growing external demands. It is frequently necessary to use non-standard reinforcement methods. Existing reinforced concrete retaining structures are frequently used to support new additional loads from newly developed facilities. In such instances, the employment of EDT drill-injection piles enables for the resolution of difficult geotechnical issues related to prospective base reinforcement.

Keywords: Geotechnical construction; Electric Discharge Technology (EDT); Bored-injection EDT pile; Ground anchor EDT

INTRODUCTION

Technological aspects of increasing the reliability of existing retaining walls

Construction of industrial and civil facilities in congested areas necessitates a unique approach to the preservation and reliable functioning of surrounding area. The electric discharge technology of the EDT pile device is one of the most in demand to tackle the geotechnical challenges related with this problem. The city of Nizhny Novgorod was used as an example of geotechnical construction for a multi-storey public building. The proposal called for injection EDT piles to be used in the construction of the hotel's ten-storey building. The complex was built in the historic Volga riverbed, which presented tremendous engineering and geological challenges [1-4]. The following Engineering Geological Elements (EGEs) describe the geological and engineering part of this site (from top to bottom) (Table 1).

Table 1: The engineering-geological section.

1	**EGE-1**	Bulk soil (untracked slouch with sand and construction debris)
2	**EGE-2**	Non-resistant tight and soft-plastic forest loam
3	**EGE-3**	Non-prosthetic, fluid-plastic forest lobe
4	EGE-4	Tight and soft-plastic sliver
5	EGE-5	Solid and semi-solid pestroud clay
6	EGE-6	Clay polymict sand

CASE PRESENTATION

A high level of underground (non-porous) water characterises the building site. The facility's construction began 5 years before the main construction began, with the installation of a pit fence (depth of 9.0 m) consisting of two rows of drill piles with a diameter of 450.0 mm and a pitch of 1.0 m (Figure 1, item 3). The pit's retaining wall was constructed along nearby streets [5]. A 10-storey major housing building, placed on blocked piles, sits just near to the pit.

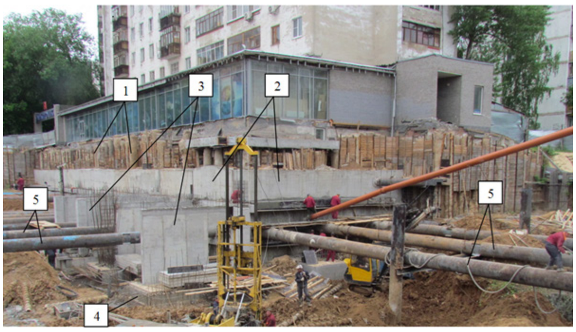

Figure 1: The scheme of retaining walls of the boiler is fixed by 1000 mm steel tubes: 1-existing boring piles of the pit fence; 2-fencing of cast in-situ reinforced concrete; 3-monolithic reinforced concrete buttresses to reinforce the existing retaining wall; 4-cast-in-situ reinforced concrete grillage; 5-existing steel tubes for reinforcing retaining walls.

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The lack of a monolithic strapping reinforced concrete belt at the top of the injection piles was a shortcoming of the built fence. When the hole was torn apart, this wickedness was revealed. On the side of the adjacent building, a row of fences leaned towards the excavation (maximum horizontal movement reached 85.0 mm). Deformation fissures occurred on the apartment building's outer walls as a result of the scenario. At the same time, the installed plaster beacons shattered and preceded to tear, demonstrating the walls and apartment building ongoing deformation. All of the walls on the pit's opposite sides are also distorted [6,7].

The head project organisation was asked by the emergency committee, which was formed in response to the pre-emergency scenario, to devise emergency measures to stabilise the deformations of both the erected retaining wall and the nearby existing building. As a result, a steel tube spacing scheme with a diameter of 1,000.0 mm was created for the retaining wall (Figures 1 and 2, item 5), which was constructed on two levels in mutually perpendicular directions [8-10]. These actions have contributed to the critical situation's stabilization. The apartment building's plaster beacons ceased tearing, and the retaining wall's horizontal movements were halted. The geotechnical investigation is still ongoing. The spacers were inserted at a depth of 4.5-6.5 m at the design depth of 9.0 m. The object had been frozen for more than five years.

In response to the appearance of an investor, it was decided to construct a ten-story public facility on the previously scheduled construction site. At the same time, the designers had to account for the size of the platform in the inner contour of the drill pile barrier, (Figures 1 and 2, item 1), as well as existing retaining wall reinforcement plans using steel pipe struts, (Figures 1 and 2, item 3).

The presence of frequently arranged horizontal pipes created a unique technical challenge in creating underground reinforced concrete foundation structures in front of builders. The optimal solution to the problem is to remove the steel pipes and replace them with more advanced geotechnical reinforcement technologies. At the same time, the retaining wall of the fence adjacent to the existing ten-storey residential structure remains the weakest link. A common decision was taken to install buttresses (Figures 1 and 2, item 3) between existing spacers to support the pit fence near the living house with a monolithic reinforced concrete structure (Figures 1 and 2, item 2). The use of EDT injection piles (Figure 3, item 2) in the form of individual blocks of cast-in-situ reinforced concrete grillage created using electric discharge technology as a base for cast-in-situ reinforced concrete sprouts (Figure 1, item 4) buttresses was suggested (EDT technology). For the stability of the counterforce against a shift from horizontal forces, 0.35 m diameter and 12.0 to 19.0 m long EDT piles, depending on the engineering and geological circumstances in a part of the construction site, are required. The captures determined the arrangement of buttresses: 1. ready buttress with a set of design strength of all its elements; 2. disassembly of one steel pipe. The braces are replaced with buttresses in this sequence. Because the distance between the pipes was three metres, it was decided to install EDT piles with the drilling rig Berkut (Figure 3, item 1). Space builders strewn sand on his arrival in the intertube. The EDT piles had to be installed between pipes in extremely difficult conditions, and the earth from the pit had to be removed manually. Monolithic reinforced concrete buttresses were structural structures for above-ground load-bearing walls, it should be noted.

Figure 2: Fragments of cast in-situ reinforced concrete buttresses: 1-existing boring piles of pit fencing; 2-fencing of cast in-situ reinforced concrete; 3-monolithic reinforced concrete buttresses to reinforce the existing retaining wall; 4-monolithic reinforced concrete grillage; 5-existing gain firing pipe.

Figure 3: Pile field under monolithic reinforced concrete buttress: 1-heads of injection EDT piles; 2-concrete preparation for the construction.

RESULTS AND DISCUSSION

As a result, an algorithm for the building of buttresses was established, the positions of which are given below, in order to ensure safe operation of the retaining wall during the zero cycle construction, as well as to create circumstances for dismantling steel pipes of the retaining structures (Table 2).

Table 2: Buttresses arrangement algorithm.

1	Filling with fine-grained intertube sand
2	Site preparation for the installation of ERT piles (see in Figure 3, item 2) (excavation, sand and concrete preparation)
3	Arrival of the drilling rig and the construction of the ERT drilling pile (see in Figure 3, item 2) under reinforced concrete grillage (See Fig. 1 and 3, Item 4) monolithic buttresses (see in Figures 1 and 2, item 3)
4	Construction of a vertical monolithic reinforced concrete wall on the external side of drilling piles (see in Figures 1 and 2, item 2)
5	The device of monolithic reinforced concrete grillage and buttress with opiranium about a monolithic reinforced concrete wall (see in Figures 1 and 2, item 2)
6	After the set of design values for the strength of the concrete of the component elements of the buttress, one steel pipe of the spacer structure is dismantled
Note: The buttresses were designed by grippers:	
1	Ready-made monolithic reinforced concrete buttress (see in Figures 1 and 2, item 3) with a set of design strength of all its component elements
2	Disassembly of one steel pipe, provided the concrete strength of all components of the monolithic buttress is set
In such a sequence all the struts (see in Figures 1 and 2, item 5) on cast-in-situ reinforced concrete buttresses (see in Figures 1 and 2, item 3)	

The above algorithm's implementation allowed the spacers to be dismantled in phases. There were no more deformations in the retaining wall or the residential home. A single contractor organization was responsible for the construction of EDT drilling piles under the foundations of buttresses, buttresses, and the castings themselves. At the same time, daily monitoring of horizontal retaining wall movements and deformations of sedimentary marks of the dwelling house was carried out to ensure that no violations in the process chain (algorithm) at this site occurred: Drilling-concreting-electro-hydraulic processing of the walls and the well's heel-installation of reinforcement cage.

Stages that must be completed in order to validate that the EDT designed piles under the buttress foundations are in compliance with the project:

1. The strength tests for pre-fabricated cubes of fine-grained concrete for piling, as described above, confirm the design values.

2. The static load tests on the vertical compressive load of the EDT test piles confirm the design values.

CONCLUSIONS

1. Phased disassembly of the retaining tubes was possible thanks to geotechnical work on the implementation of the above algorithm. There were no more deformations in the retaining wall or the multi-storey apartment complex.

2. Based on extensive observations of the technical condition of a multi-story large-panel residential structure, it is reasonable to infer that the plan to build monolithic reinforced concrete buttresses is technically proficient.

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