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Review Article

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Increasing the Reliability of Existing Retaining Walls

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ABSTRACT

The problem of increasing the bearing capacity of foundations is always an urgent problem in modern geotechnical construction. With additional increased external loads on existing retaining structures, the use of traditional technologies to ensure their stability is not always justified. Often there is an urgent need to use non-standard methods of strengthening the bases. There are frequent cases of using existing retaining reinforced concrete structures for new additional loads from newly built objects. In such cases, the use of EDT bored piles allows solving complex geotechnical problems associated with the possible strengthening of overloaded foundations.

Keywords: Geotechnical Construction, EDT Electric Discharge Technology, EDT Bored Pile, EDT Ground Anchors

The construction of industrial and civil facilities in cramped conditions requires a specific approach related to ensuring the safety and reliable operation of the surrounding buildings [1-11]. To solve geotechnical problems related to this problem, the electric discharge technology of EDT piles is one of the most popular [12-15].

One of the cases of geotechnical construction for a multi-storey public building in the city of Nizhny Novgorod is considered. The project for a ten-story hotel building provided for the installation of ERT bored-injection piles.

The construction of the facility was carried out in difficult engineering and geological conditions in the old bed of the Volga River. The engineering-geological section in this area is represented by the following engineering-geological elements (EGE) (from top to bottom):

1	**EGE-1**	Bulk soil (non-compacted loam with sandy loam and construction debris)
2	**EGE-2**	Non-sagging hard- and soft-plastic loess loam
3	**EGE-3**	non-subsidence fluid plastic loess loam
4	**EGE-4**	Hard and soft plastic loam
5	**EGE-5**	Hard and semi-hard variegated clay
6	**EGE-6**	Clay polymictic sand

The construction site is characterized by a high level of underground (non-pressure) water. The construction of the facility began 5 years before the start of the main construction with the erection of a foundation pit (9.0 m deep) from two rows of bored (drilled) piles with a diameter of 450.0 mm with a step of 1.0 m (see pos. 1 Figure 1 and 2). The retaining wall of the excavation was built along the adjoining streets. Directly adjacent to the foundation pit is a 10-storey large-panel residential building erected on driven piles.

The disadvantage of the constructed fence was the absence of a monolithic reinforced concrete strapping belt along the top of the injection piles. This flaw came to light only when excavating the pit. A row of fence piles from the side of the adjoining building leaned towards the pit (the maximum horizontal movement reached 85.0 mm). As a result of this situation, deformation cracks appeared on the outer walls of the residential building. At the same time, the installed gypsum beacons broke and continued to tear, thus proving the ongoing deformation of both the wall itself and the residential building. At the same time, all walls on the other sides of the pit are also deformed.

Urgently created in connection with the pre-accident situation, the emergency commission instructed the head design organization to urgently develop emergency response measures to stabilize the deformations of both the erected retaining wall and the adjoining existing building. As such measures, a scheme was developed to reinforce the retaining wall in the form of spacer structures made of steel pipes with a diameter of 1000.0 mm (see item 5 of Figure 1 and 3), located at two levels in mutually perpendicular

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directions. These measures helped to stabilize the critical situation that had arisen. The gypsum beacons on the residential building stopped tearing, the horizontal movements of the retaining wall were suspended. At the same time, geotechnical monitoring continued. With a design excavation depth of 9.0 m, the spacers were placed at a depth of 4.5-6.5 m.

In this frozen state, the object was more than five years.

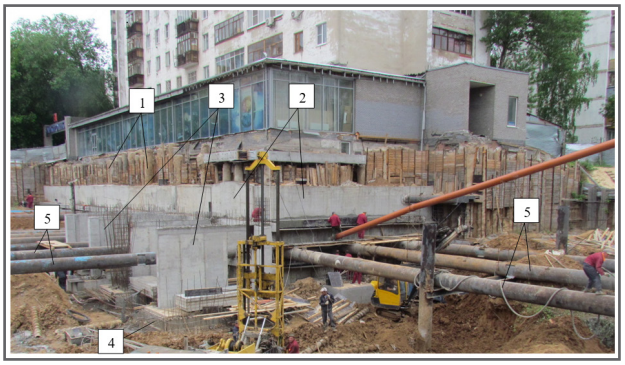

Figure 1: Scheme of fixing the retaining walls of the excavation by shootings from steel pipes 1000 mm: 1-existing bored piles of the excavation fencing; 2-fencing of the pit from monolithic reinforced concrete; 3-mono-ite reinforced concrete buttresses to reinforce the existing retaining wall; 4-monolithic reinforced concrete grillage; 5-existing chimneys-firing to reinforce retaining walls

In connection with the appearance of an investor, it was decided to erect a completely different building from the one previously planned for construction at this construction site - a ten-story public facility. At the same time, the designers had to fit into the dimensions of the site in the inner contour of the completed fence made of drilled piles (item 1 of Figure 1 and 3), and also take into account the existing schemes for reinforcing retaining walls using spacer structures made of steel pipes (see item 3 on figure 1 and 2).

The construction of buried reinforced concrete foundation structures faced a special technical difficulty for builders due to the presence of often located horizontally mounted pipes. The ideal task is a) dismantling of steel pipes and b) replacement with more advanced geotechnical reinforcement technology. At the same time, the retaining wall of the fence at the junction with the existing ten-story residential building still remains the weakest link. By a joint decision, it was decided to arrange buttresses (see pos. 3 in figure 1 and 2), supporting the pit fence near the residential building through a monolithic reinforced concrete structure (see pos. 2 in figure 1 and 3), arranged between the existing expansion constructions. The base for monolithic reinforced concrete grillages (see pos. 4 figure 1 and 3) of the buttresses was proposed to use ERT bored injection piles (pos. 2 figure 2) in the form of separate bushes for a monolithic reinforced concrete grillage, manufactured using electric discharge technology (ERT technology). The need to use EDT piles with a diameter of 0.35 m and a length of 12.0 to 19.0 m, depending on engineering and geological conditions in one or another part of the construction site, is due to the purpose of ensuring the stability of the buttress against shear from horizontal forces. It was decided to arrange buttresses with grippers: 1. Finished buttress with a set of design strength of all its elements; 2. Dismantling of one steel pipe. In this sequence, the struts are replaced with buttresses. In connection with the fact that the gap between the pipes was three meters, it was decided to use the drilling rig "Berkut" for the installation of ERT piles (see item 1, figure 2). To enter it into the annular space, the builders covered it with sand. EDT piles had to be installed in very difficult conditions between the pipes, and the removal of soil from the excavation was carried out only manually. It should be emphasized that the monolithic reinforced concrete buttresses were the load-bearing building structures for the above-ground load-bearing walls.

1	Filling the annular space with fine-grained sand
2	Preparation of the site for the installation of ERT piles (item 2 of Figure 2) (digging of the soil, arrangement of sand and concrete preparations)
3	Check-in of the drilling rig and arrangement of a cluster of EDT bored-injection piles (item 2, figure 2) under a reinforced concrete grillage (item 4, figure 1, 3) of a monolithic buttress (item 3, figure 1, 3)
4	Arrangement of a vertical monolithic reinforced concrete wall on the outside of the drilled piles (see item 2, figures 1 and 3)
5	Arrangement of a monolithic reinforced concrete grillage and a buttress supported by a monolithic reinforced concrete wall (see pos. 2 figure 1 and 3)
6	After a set of design values for the strength of concrete of the constituent elements of the buttress, one steel pipe of the spacer structure is disassembled

Notes:

The device of the buttresses was made by grippers:

1	Ready-made monolithic reinforced concrete buttress (item 3 figure 1 and 3) with a set of design strength of all its constituent elements
2	Dismantling of one steel pipe, subject to the curing of concrete of all components of a monolithic buttress

In this sequence, all spacers (pos. 5 figure. 1 and 3) were replaced with monolithic reinforced concrete buttresses (pos. 3 figure 1 and 3)

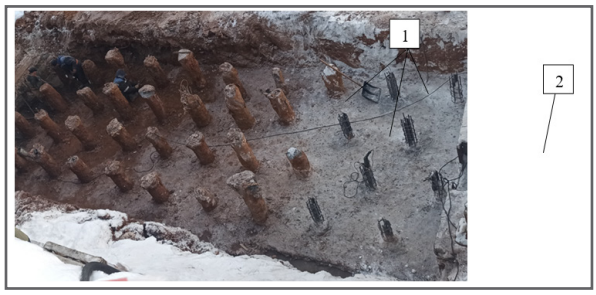

Figure 2: Pile field for a monolithic reinforced concrete buttress: 1-heads of EDT bored injection piles; 2 - concrete preparation for grillage.

Figure 3: Fragments of completed monolithic reinforced concrete buttresses: 1-existing bored piles to enclose the excavation; 2-fencing of the pit from monolithic reinforced concrete; 3-monolithic reinforced concrete buttresses to reinforce the existing retaining wall; 4-monolithic reinforced concrete grillage; 5-existing pipe - amplification shooting.

The work on the implementation of the above algorithm made it possible to gradually dismantle the spacer pipes. No further deformations of the retaining wall and residential building were found.

The installation of ERT bored piles for buttress foundations, buttresses, as well as the grillages themselves, were carried out by one contractor. At the same time, horizontal movements of the retaining wall and deformations of the sedimentary marks of the residential building were monitored daily, due to which there were no violations in the technological chain (algorithm) at this site: "drilling - concreting - electro-hydraulic treatment of the walls and the heel of the well - installation of reinforcement cages ".

Mandatory stages confirming the compliance with the project of the designed EDT piles for the foundations of the buttresses:

1	Strength tests of prefabricated cubes of fine-grained concrete intended for the manufacture of piles, according to the algorithm given above, confirm the design values
2	Static load tests on the vertical compressive load of experimental EDT piles confirm the design values

Conclusions

1. The implementation of geotechnical work to implement the above algorithm made it possible to gradually dismantle the spacer pipes. No further deformations of the retaining wall and multi-storey residential building were found.
2. Long-term observations of the technical condition of a multi-storey large-panel residential building make it possible to conclude that the decision made on the installation of monolithic reinforced concrete buttresses is technically correct.

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