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Research Article

Installation of Pit Fencing in Cramped Conditions

Sokolov NS*

Chuvash State University, Russia

***Corresponding author:** Sokolov NS, Chuvash State University, Russia.

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Abstract

Construction of facilities in cramped conditions is always a complex geotechnical problem associated with ensuring the basal emergency operation of buildings and structures of the surrounding buildings. In the arsenal of geotechnicians, a great potential of geotechnical technologies for the installation of pit fences has been accumulated. Often, not everyone is suitable for the conditions of their use in cramped conditions. The most suitable technologies for such cases are the drilled wells used (wells for drill piles and soil anchors) with their subsequent filling with concrete and at the same time not disturbing the stress-strain state of the surrounding soil. The use of drilling piles and soil anchors arranged using electric discharge technology (ERT technology) in many cases successfully solves the problem of construction in cramped conditions. The article cites one of the geotechnical cases of fencing the pit in particularly cramped conditions. The work is an overview.

Keywords: Geotechnical construction; Electric discharge technology of ERT; Drill injection pile ERT; Soil anchors ERT

Introduction

The construction of buildings and structures in cramped conditions requires from builders and geotechnicians close attention [1-12] related to the need to preserve the objects of the surrounding buildings. In this article, a successful example of fencing the pit of a building under construction, located surrounded by existing structures, is given.

Administratively, the construction site of a six-storey residential building is located in Nizhny Novgorod in cramped conditions of urban development. It was built on a non-developmental territory. Surrounded by a house under construction in the zone of geotechnical influence, there are six objects of existing development (see Figure 1), including two objects of the OKN (objects of cultural heritage).

Geomorphologically, the survey site is located on the watershed plateau of the Oka and Volga rivers. Elevations of the surface of the earth within the site vary from 135.9 to 136.3 B.S. (at the mouths of engineering and geological workings). The terrain is planned. The engineering and geological structure of the site to a depth of 20.0 m is represented by undissected upper-middle quaternary loess loams (prQII-III), opened with a capacity of 1.7-2.5 m, undissected upper-middle quaternary loam loams (prQII-III), with a capacity of 14.5-16.6 m, from the surface of the sediments covered with bulk soil (tQIV), with a capacity of 1.7-3.0 m.

All engineering and geological workings are plotted on the layout plan of engineering and geological workings. The geological and lithological structure of the site is characterized by columns of wells and engineering-geological sections. The hydrogeological conditions of the site to a depth of 20.0 m at the time of the survey (July-August 2017) are characterized by the presence of an aquifer confined to Quaternary sediments. The groundwater level was recorded at depths of 4.5-6.4 m. The aquifer is non-pressure, the water-containing soils are loess loam. Water wells have not been opened. The aquifer is fed by atmospheric infiltration precipitation and leaks from water-carrying communication.

The geological and lithological structure of the site is presented in Table 1 (Table 1) (Figures 1-6).

Figure 1: Boundaries of the zone of geotechnical influence.

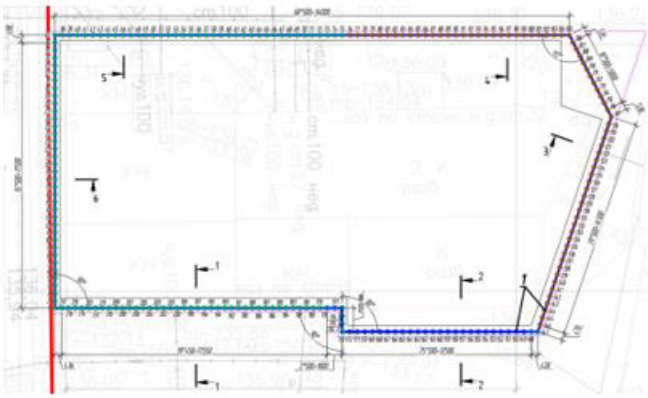

Figure 2: Plan for the location of drill injection piles ERT fencing of the pit.

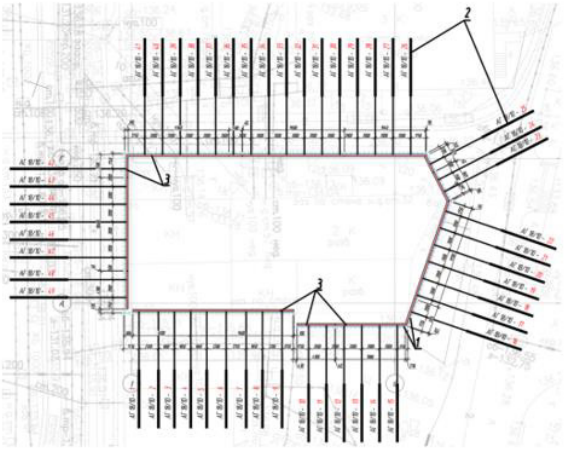

Figure 3: Scheme of placement of soil anchors ERT fence of the pit: 1 - drill injection piles ERT; 2 - ground anchors ERT of the first level; 3 - monolithic reinforced concrete strapping belt.

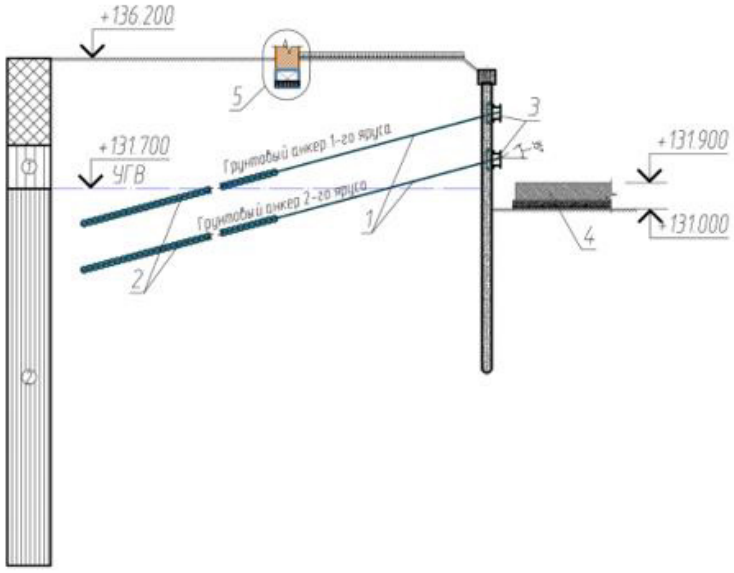

Figure 4: Characteristic section of the pit fence: 1, 2 - ground anchors ERT of the first and second levels; 3 - steel anchor belts; 4 – monolithic slab reinforced concrete foundation of the 6-storey object under construction; 5 – the foundation of one of the buildings of the existing buildings.

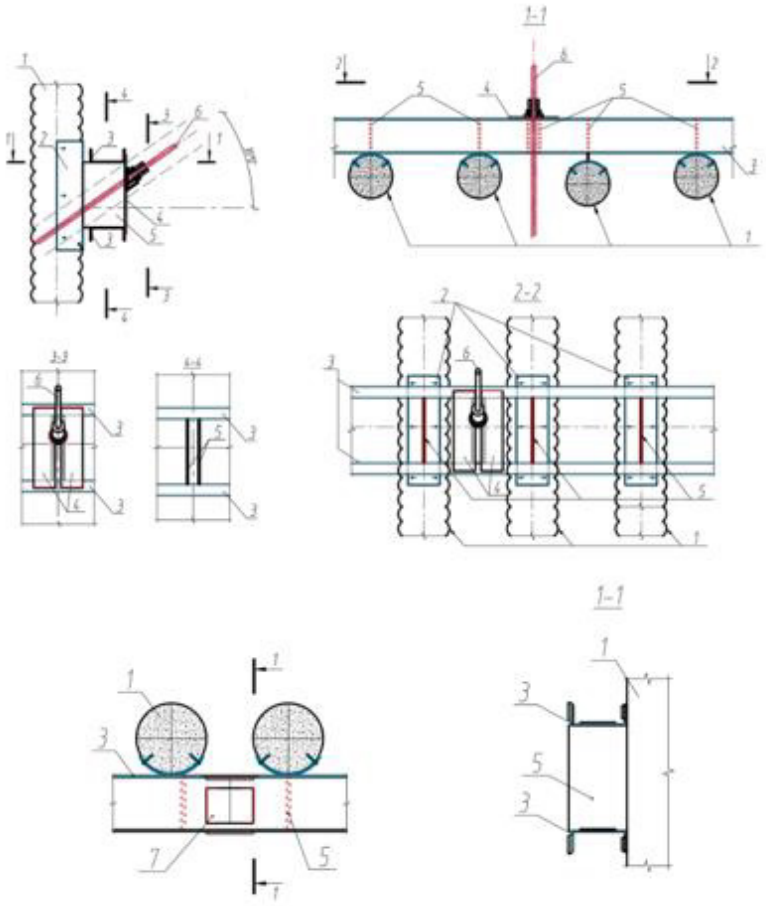

Figure 5: Scheme of the knot for attaching soil anchors to the strapping belt: 1-brown-ediv pile ERT; 2-stop anchor belt; 3-anchor belt made of steel profiles; 4-steel plate; 5-stiffening ribs of the anchor belt; 6-rod made of high-strength anchor belt reinforcement; 7-knot fastening of the anchor belt joint.

Figure 6A: Fragment of the pit fencing plan: 1-boroinjective ERT piles; 2-ground ERT anchors; 3-anchor strapping belt; 4-monolithic reinforced concrete strapping belt.

Figure 6B: Fragment of the pit fencing plan: 1-boroinjective ERT piles; 2-ground ERT anchors; 3-anchor strapping belt; 4-monolithic reinforced concrete strapping belt.

Table 1: Resource requirements by component.

Layers	Age, Genesis, Soil Description, Area Distribution	Power, m
Modern Proluvial-Deluvial Deposits (pdQIV)		
1	tQIV – bulk soil: brown dusty sand, with the inclusion of crushed stone, construction debris, reinforcement; brick; loam with the inclusion of sand, bricks, crushed stone, construction debris; dark brown loam, with the inclusion of construction debris with an admixture of peat. Opened with all wells from the surface.	1.7-3.0
Undivided Middle-Upper Quaternary Deposits (prQII-III)		
2	prQII-III is a loess brown loam, dark brown, with layers of loam. Opened by all wells in the middle part of the section.	14.5-16.6
3	prQII-III - Loess brown loam, with layers of loam. Opened by all wells	Opened1.7-2.5

Table 2: Resource requirements by component.

1. Conditions for the Construction and Operation of Structures
During the installation of the retaining wall, strictly observe the stages of soil development:
1. Perform the installation of a tongue-and-groove fence made of ERT drill piles in the design position.
2. Soil anchors are performed after the 1st stage of soil development.
3. Pretension of soil anchors is carried out in accordance with VSN 506-88.
4. In parallel with the installation of ground anchors and their pretension, a wooden fence is installed.
5. The second stage of development provides for the excavation of the soil to the mark of the bottom of the pit.
6. The development of the soil should be started only if the strength of the erected structure meets the requirements of this project.
7. During the operation of soil anchors, dynamic, vibrational effects on them are not allowed before filling the sinuses of the pit.
8. After the development of the pit, perform the installation of a drainage ditch filled with filter material (crushed stone, gravel) in accordance with SP 45.13330.2017. Groundwater is diverted to sumps equipped with submersible pumps.
2. Construction of Anchor Fastening
1. Anchor fastening structures: ERST ground anchors, parts for fastening the support of the ground anchor.
2. Design load on the anchor Pw.
3. The free length of the ground anchor is due to the prism of the collapse of the pit wall, the shape of which is determined by calculating the overall stability of the structure by the method of logarithmic spirals.
4. Accepted marking of soil anchors: AG 15/8 (total length of anchor 15 m, root length 8 m).
5. Drilling diameter for ground anchors - 150 mm, performed at an angle of 30 degrees. to the horizon.
6. The service life of the temporary anchor fastening in accordance with the adopted design scheme is not more than 2 years.
3. Anchor Fastening Designs
1. For soil anchors, use cement mortars with a water-cement ratio (by weight) B: C = 0.5: 1.
2. For cement mortars, use Portland cement without mineral additives of the brand for strength not lower than M500.
3. The use of pozzolan, alumina and Portland cement slag is not allowed.
4. Water for cement mortars tap and technical, not containing sugars and phenols more than 10 mg / l, petroleum products and fats. Hydrogen index (pH) from 4.0 to 12.5.
5. As an anchor rod, rod reinforcement with a diameter of 36 mm of class A500C (in a plastic shell with a diameter of at least 63 mm) and screw reinforcement with a diameter of 25 mm of class At800 are used.
6. For centering in the well along the entire length of the thrust, fixators are provided (pitch not more than 2.0 m) from segments of plastic pipes with longitudinal cuts along the perimeter.
7. For the manufacture of welded frames, it is forbidden to use reinforcement made of steel grade 35GS.
8. Manual arc welding of anchor frame elements is carried out by electrodes of type E42A, E46A, E50A.
9. The distribution belt is provided of two channels No. 27 C245.
10. Parts for fastening the support of the ground anchor to the support plate (plate): spherical, conical, oblique washers, locking nut (St45).
4. Production of A Primer Anchor
1. The technological sequence of production of anchors includes the following operations:
- Formation of a well of the required depth and diameter by screw drilling.
- Filling to the wellhead with cement mortar.
- Electric discharge treatment of the well at the root level.

- Installation of the anchor frame in the design position.
2. When installing anchors, the subsequent well should be arranged at least 3.5 m from the previous one. Drilling of wells next to previously manufactured anchors is allowed only after at least 48 hours after the end of concreting the latter.
3. The bearing capacity of each anchor shall be checked before it is put into operation in conjunction with the fixed structure by means of control or acceptance tests for the maximum test load.
4. Before the start of work, the protection zones of existing underground and air communications, as well as underground structures, should be marked with an indication of the protection zone established in accordance with clause 6.1.21 of SP 45.13330.2017.
5. Well Formation by Drilling
1. Screw drilling, perform in accordance with the project of production of works.
2. Drilling rig UBG-SG "BERKUT".
3. Drilling of wells is carried out from the working marks specified in the project.
4. For the turning of drilling machines and the possibility of installing anchor frames, the width of the ground berm should be at least 15 m.
5. In the process of drilling, it is necessary to control the parameters of the soil at depth.
6. Lifting of the drilling tool should be carried out slowly after it is established that no reduced pressure is created in the bottom of the well relative to the household pressure of the soil.
7. Cementation of wells should be carried out immediately after the end of drilling. If cementation is not possible within the specified period, drilling wells should not begin.
6. Cementation of the Soil Anchor Well
1. Filling of the well is carried out to the mouth through a concrete-casting column with a diameter of at least 40 mm, lowered to the bottom. After reaching the face, the well should be washed with cement mortar. Washing with cement mortar continues until the surfacing of soil particles stops.
2. Preparation of cement mortar should be carried out on the construction site immediately before it is injected into the well. For the preparation and supply of the solution, the pneumatic supercharger PRN-500 (PRN-300) is used. Discharge pressure 0.5-5.0 MPa.
3. It is necessary to control the volume of cement mortar injected into the well, comparing it with the design, and the volume of drilled soil, and the volume of fluid pumped into the well should exceed the volume of drilled soil.
7. Program of Electro-Discharge Treatment of a well Filled with Cement Mortar
1. The power of the accumulated energy is not less than 50 kJ.
2. The length of the cable from the GIT to the electrode system is not more than 80 m, including the length of the anchor (high-voltage cable TYPE-2 – 50 m, high-voltage cable KVIM – 30 m).
3. Treatment with electrical discharges is carried out at the length of the anchor root in series of at least 13 digits at each level. The step of the levels from 0.8-0.9 m. The estimated increase in the drilling diameter (150 mm) should be brought to 200 mm, for this it is necessary to control the level of solution in the well before the start of processing one level and after the completion of processing.
4. To ensure that the total volume of the solution supplied to the well, including refilling, exceeds the volume of the well passed (the volume of soil extracted from this well).
5. Based on the results of monitoring the fall in the level of cement mortar in the experimental well or the volume of the added solution and seismic disturbances in the zone of formation of the geotechnical element, adjust the program for treating the root of anchors with electrical discharges.
8. Installation of Anchor Frame
1. Lower the anchor frame into the well should be smoothly, without jerks.
2. It is necessary to control the position of the reinforcing frame after installing it in the design position. The frame is fixed from immersion and displacement in the plan.
3. The frame before installation should be cleaned of accidentally adhered to it soil.
9. Production of Concrete Works at Negative Air Temperature
1. Three days before the concrete works, when the average daily air temperature is expected to be below +5 ° C or the minimum daily temperature is below 0 ° C, provide antifreeze additives in cement mortars.
2. Cement mortar with antifreeze additives during laying should have a temperature not lower than +10 ° C.
3. When the soil temperature is below the air temperature, the amount of anti-frost additives should be introduced on the basis of the minimum predicted temperature of the air or soil by the time the solution reaches the required strength.
4. To reduce heat loss in the process of concrete hardening after immersion in the well, the part of the reinforcement frame that comes to the surface must be insulated.
5. Overheating of cement mortar (heating more than 70 ° C) is not allowed.
6. It is allowed not to use anti-frost additives in cement mortars filled into wells below the depth of seasonal freezing of the soil.
7. After the completion of work and interruptions in work for more than 50 minutes. hoses for supplying the solution should be washed with hot water, blown with compressed air and removed to a warm room. Before the start of work, the hoses should be deployed, blown with compressed air and washed with hot water.
8. To avoid freezing of soils during interruptions in operation, open wells should be isolated from atmospheric air.

9. At temperatures below -20 ° C, work on the manufacture of soil anchors should be stopped.
10. Order of Tension of Ground Anchors
1. Before the start of work, all elements of the anchor fastening must be installed on the gripper planned for tension.
2. Oblique washers must be welded to the support plates (plates) of the steel distribution belt.
3. The strength of the cement stone of the anchor root should be at least 20 MPa. To control the set of strength in the process of manufacturing anchors, 9 cubes of 10x10x10 cm should be selected, which are tested at the age of 3.7 (for internal use) and 10 days (for reporting).
4. Control static tests are carried out, if they are not assigned, on every tenth anchor, starting with a load Of 0.2 * Ri. Test load Ri = 1.2 * Pw (according to HSE 506-88).
11. Ensuring the Quality of Production of Ground Anchors
1. Production of soil anchors should be carried out by organizations with experience in geotechnical work for at least 5 years.
2. During the manufacture it is necessary to examine:
- planned and high-altitude binding of piles of the pit fence;
- diameter and depth of wells for compliance with the project;
- the type of soil at the base of the anchor and its compliance with the project (for residues on the elements of the drilling tool in the base);
- compaction of the soil at the base of the ERT pile destroyed by the drilling tool;
- compliance of the anchor frame with the project (length, diameter, and class of reinforcement of working rods, rod connection nodes) and the depth of immersion of the frame in the well;
- quality of the cement mortar to be prepared (material consumption);
- difficulties in immersing the anchor frame under its own weight in the squash-inu (free immersion of the reinforcing frame to the design mark - indicates the absence of soil squeezes in the well and guarantees the continuity of the root shaft);
- immersion of the electrode system;
- consumption of cement mortar used in the production of ERT anchors;
3. Control of the strength of fine-grained concrete should be carried out according to GOST 18105-2010 and GOST 10180-2012 by sampling the cement mortar at the place of its manufacture and subsequent hardening under normal conditions that meet the requirements of clause 4.3.2 of GOST 10180-2012.
4. Acts of inspection of hidden works are drawn up in the form specified in SP 48.13330.2019, must be drawn up for the completed process (anchor) performed by an independent unit of performers (integrated brigade) during the shift.
5. It is not allowed to perform subsequent work in the absence of executed acts for hidden works on completed technological processes for the manufacture of ERT anchors that have not been inspected by the customer's technical supervision.
6. Geotechnical works should be carried out in accordance with SP 45.13330.2017, SP 72.13330.2016, SP 70.13330.2012, SP 48.13330.2019, SP 49.13330.2010, SNiP 12-04-2002, TR 50-180-06, project of work production (PPR).

Below in Table Figure 2 shows the algorithm for the device of ERT drill injection anchors (Table 2).

Conclusion

1. Brown-injection piles and soil anchors ERT, being buried reinforced concrete structures of the pit fence during the construction of a six-story residential building, made it possible to build an object without negative consequences for buildings of the surrounding buildings.

2. The algorithm for the installation of soil anchors ERT has been tested on many objects of geotechnical construction. It is mandatory in the manufacture of brown injection ERT anchors.

Acknowledgement

None.

Conflict of Interest

No conflict of interest.

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