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Earth Earth Anchor as a Deep Concrete Concrete Structure

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SUMMARY

Construction development of territories with complex engineering and geological conditions with the presence of unstable rugged relief is a complex geotechnical problem. Issues related to ensuring the safe production of installation work for the construction of any object in such territories relate to a multifactorial problem associated, first of all, with the development of special geotechnical technologies tied to real geotechnical conditions of the relief, loads from existing buildings and structures and, secondly, real their implementation at a specific construction site. Modern geotechnical construction has in its arsenal methods and technologies for solving these complex problems. The use of advanced computer programs such as GeoWall, GeoStab, Plaxis, etc. allows the development of geotechnical objects of any complexity. To identify the most appropriate geotechnical technology, it should be mandatory to use the interactive design method. This is "a developed project - an experimental site - a real project". Moreover, this type of design should be multivariate using various geotechnical technologies and geotechnical structures. The feasibility study of all elements in interactive design is of no small importance. Any element in the design must be economically feasible and technically feasible. The considered case from the geotechnical practice of the construction of the object confirms the fact that thanks to the availability of modern design and production tools, it is possible to solve any complex problems.

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One of the cases from the geotechnical practice of constructing objects on a landslide slope is considered. Administratively, the survey site is located in the central part of the city of Cheboksary, at 35A Gagarina Street. In geomorphological terms, it is a gentle denudation-accumulative slope of the Kaibulka river valley, complicated by buried gullies and a strongly branched gully-gully system of the 2nd and higher orders with permanent streams. The absolute marks of the earth's surface within the site vary from 129.1 to 137.5 m (along the mouths of geotechnical workings). The relief is planned. The geological and lithological structure of the site is characterized by the columns of wells No. 1-4, 9-11,15, 17 (see Figure 1). Geological and lithological structure of the site based on the data of the report on engineering and geological surveys up to the investigated depth, 7 engineering and geological elements (IGE) were identified (see Fig. 2). The hydrogeological conditions of the site to a depth of 23.0 m at the time of the survey are characterized by the presence of several aquifers (WG) of groundwater. The first WG is free-flowing, confined to technogenic formations, penetrated by all wells. Absolute elevations of the UPV -128.5m (well No. 9), 135.7m (well No. 1). Vg is powered by leaks from water-carrying utilities. The water-bearing soils are technogenic formations and loams (IGE No. 1.2). Upper Permian clays (IGE No. 3) serve as a local aquiclude; the second aquifer is confined to the primary Upper Permian formations.

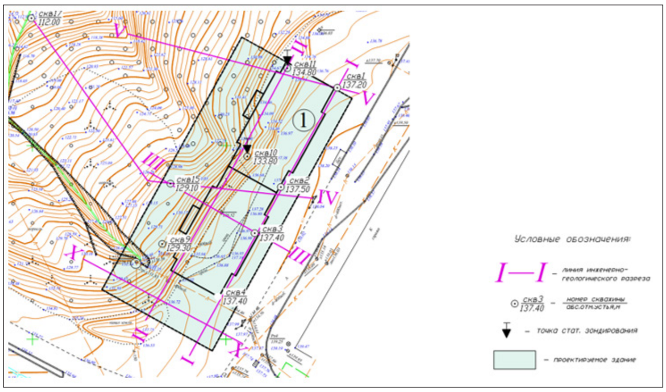

Figure 1: Copy from the General Construction Plan of the Object

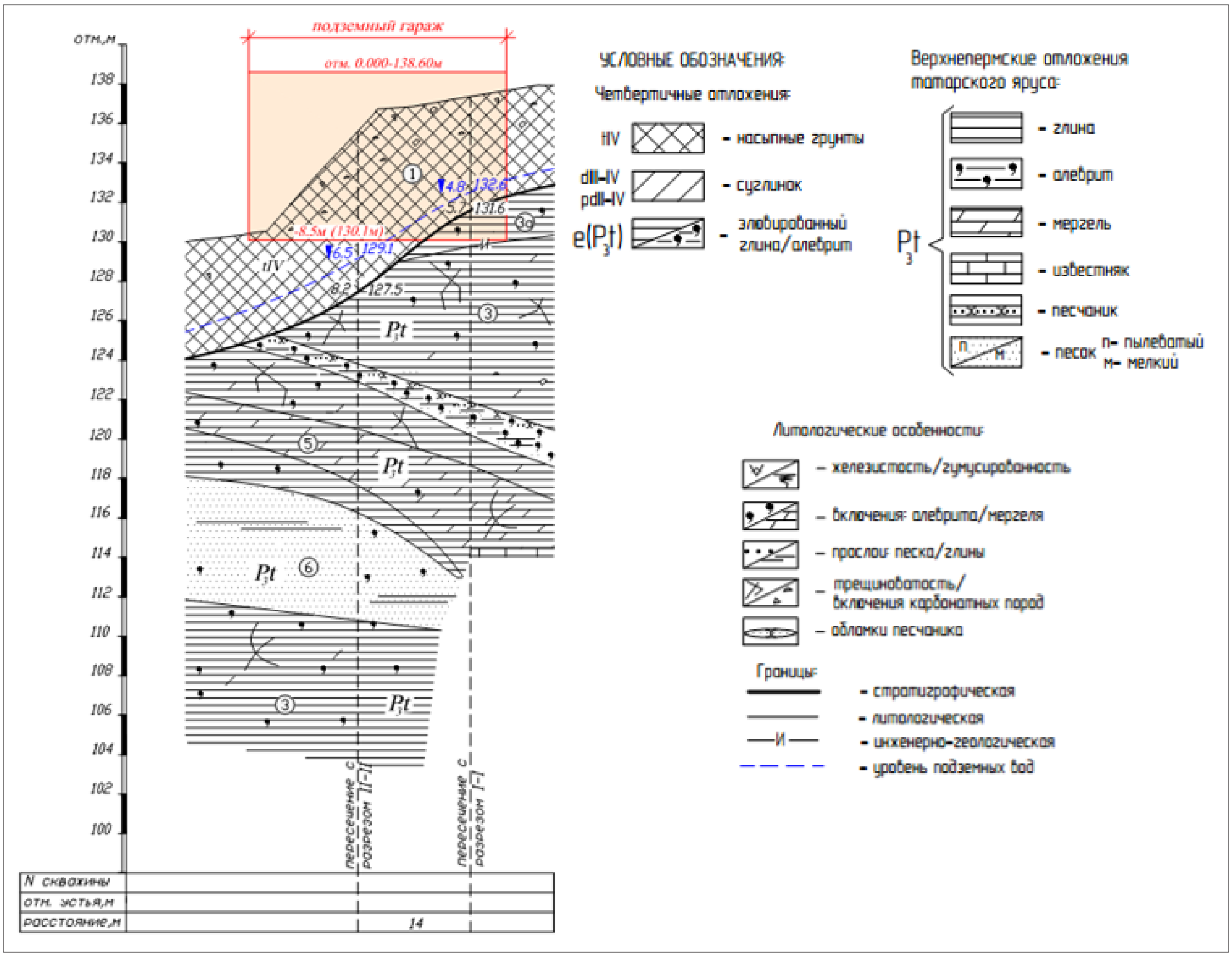

Figure 2: Engineering-Geological Section of the Construction Site

Table 1: Standard Physical and Mechanical Characteristics of Soils

IGE	Soil type	h, m	γ I , kN / m³	s I , kPa	φ I , hail	k s , kN / m ³	λ	E, MPa	ν
1	Soft-plastic loam	8.6	19.6	16.0	11.0	2000	0.60	13.0	0.36
2	Hard-plastic loam	4.0	19.6	11.0	12.0	4000	0.57	15.0	0.36
3	Clay, refractory	2.2	19.9	29.0	20.0	4000	0.40	18.0	0.25
4	Clay hard	1.3	20.1	25.0	23.0	6000	0.52	22.0	0.34
5	Clay, refractory	2.5	19.9	29.0	20.0	4000	0.40	18.0	0.25
6	Semisolid clay	20.0	21.3	26.0	24.0	6000	0.34	27.0	0.25

Constructive solutions for recessed structures (see Fig. 3) are:

1. The special auxiliary containment structure is a retaining wall consisting of fence structures and anchorage structures.
2. The structures of the pit fencing in the area under consideration are 350 bore- injection piles made by electric discharge technology (piles-ERT [14-21]) fixed from horizontal displacement by ground anchors 18 m and 17 m long according to ERT technology, made at an angle of 30O. The spacing of ground anchors, as well as the distance from the bottom of the pit to the corresponding tier of anchors, are taken in accordance with the plans specified in the project.
3. Ground anchors (ERT anchors) are arranged after the first stage of excavation development, according to the engineering-geological sections specified in the project, and are prestressed elements with a reinforced concrete root obtained by electric discharge treatment of the soil of its walls (Fig. 3.4).

Strength calculations of retaining wall elements were performed in the GeoWaLL software package based on the Blum-Lameyer method ("elastic line" method).

The erection and operation of the structures of ground anchors were carried out according to the following algorithm (Fig. 3): During the construction of the retaining wall, the stages of soil development were developed;

1. The 1st stage of soil development provides for the development of soil to the marks indicated on the corresponding sections; after installing the sheet piling in the design position.
2. Ground anchors of the 1st tier are performed after the 1st stage of soil development at an elevation of + 132.350m.
3. The second stage of development provides for excavation to the absolute level (+ 130.850m).
4. The third stage of development provides for excavation up to the design level of the pit bottom + 129.150m.
5. The development of the soil should be started only if the strength of the erected structure meets the requirements of the project.
6. During the installation of the sheet piling, before filling the sinuses of the foundations, geotechnical monitoring of the deformations of the surrounding buildings is carried out.
7. During the operation of ground anchors, dynamic, vibration effects on them are not allowed before backfilling the sinuses of the excavation.
8. It is not allowed to exceed evenly distributed loads on the edge more than specified in the project.

The device of ERT injection piles represents the following sequence

Well formation by drilling

- Auger drilling will be carried out in accordance with the project for the production of works. Installation for drilling UBG-SG "BERKUT" or similar.
- Wells are drilled from the working marks specified in the project.
- To turn the drilling machines and the possibility of installing anchor frames, the width of the soil berm must be at least 18 m.
- In the process of drilling, the parameters of the soil in depth are monitored: to establish the characteristics of the base soil by the remains of soil on the elements of the drilling tool, to fix this fact with a corresponding entry in the log of pile work. The correspondence of the soil found at the bottom of the well to the design values at the level of the anchor root is established.
- The lifting of the drilling tool is carried out only after it has been established that a reduced pressure is not created at the bottom of the well relative to the natural pressure of the soil.

Cementation of a ground anchor well

The well is filled up to the wellhead through a concrete casting column with a diameter of at least 40 mm, lowered to the bottom by the HMW method (top rising pipes). After reaching the bottom, the well must be flushed out with cement slurry. Flushing with cement slurry continues until the floatation of soil particles stops. The preparation of the cement slurry is carried out at the construction site immediately before it is injected into the well. For the preparation and supply of the solution, a PRN-500 (PRN-300) pneumatic spray blower is used. The volume of cement slurry injected into the well is monitored , comparing it with the design value, and the volume of drilled soil, and the volume of the slurry pumped into the well must exceed the volume of drilled soil.

Program of electric discharge treatment of a well filled with cement mortar

The required power of the accumulated energy is not less than 50 kJ.

The length of the coaxial cable from the PCG to the electrode system is no more than 80m, including the length of the anchor (high-voltage cable TIP-2 - 50m, high-voltage impulsive low-inductance cable (KVIM) - 30m).

Processing with high-voltage electrical discharges is carried out along the length of the root of the ground anchor in series of at least 15 discharges at each level. The step of the levels is from 1.0 m. The calculated increase in the drilling diameter (150 mm) of the anchor root must be brought to 200 mm; for this, the level of cement slurry in the well is controlled before the start of treatment at one level and after the completion of treatment. For "failure" is considered a decrease in the level of the solution in the well for the last 5 discharges no more than 10 mm. To establish the fact of "failure", the change in the level of the solution in the well is monitored after each discharge or a series of 5 discharges.

The control over the achievement of the total volume of the solution fed into the well, including the top-up of a level exceeding the volume of the drilled well (the volume of soil extracted from this well), is carried out.

Based on the results of monitoring the drop in the level of cement slurry in the test well or the volume of added solution and seismic disturbances in the formation zone of the geotechnical element, the program for treating the anchor root with electric discharges is adjusted.

Installation of the anchor frame

The anchor frame lowers smoothly, without jerking.

The position of the reinforcement cage is monitored after installing it in the design position. The frame is secured against accidental immersion and displacement in the plan. Before installation, the frame is cleaned of soil accidentally adhered to it.

The procedure for tensioning ground anchors includes the following sequence

Before starting work , all anchoring elements are installed on the grip planned for tension.

Oblique washers are welded by electric arc welding directly on the construction site to the base plates (plates) of the steel distribution belt.

The cube strength of the cement stone of the anchor root must be at least 20 MPa. To control the strength gain during the manufacture of anchors, 9 cubes 10x10x10 cm are selected, which are tested at the age of 3.7 (for internal use) and 10 days (for the report).

The test load is assigned according to [1] equal to Pu = 1.2* Pw. Control tests are carried out on every tenth anchor, starting from the load Po = 0.2* Ru. The anchor is loaded in steps. Loading order: First stage - P1; The second stage is P2; The third stage is P3; The fourth stage is P4; The fifth stage is P5; Sixth stage - P6; The seventh stage is the test load Pu. Each step is kept for at least 15 minutes until the stabilization of the deformations of the ERT anchors. Then, unloading is carried out to the value Po, at which elastic and residual displacements are measured. The values of the displacements are recorded at each stage every 3 minutes. The last stage of the load is maintained until the anchors stabilize for 30 minutes, then they are reduced to the value of Po, the elastic and residual displacements of the anchors are measured and the load is brought to the value of Pb (blocking load), then the anchor is fixed on the supporting structure.

If the test load is not reached during the control tests, the load of the last stabilized stage (load-bearing capacity of the ground anchor) is taken as the test load, followed by the calculation of the design load on the anchor, taking into account the reliability factor, equal to 1.2. Taking this into account, the author of the project corrects the blocking load and corrects the design solution.

At small values of the absolute displacements of the soil anchor (less than 20 mm), after the stabilization of deformations is achieved, during control tests, the anchor is loaded with steps equal to Po = 0.2* Pu with maintaining conditional stabilization of deformations at each new stage. At the same time, the strength of the material and the anchoring units for over-design loads must be ensured.

Each working anchor is subject to acceptance tests, with the exception of proof tested anchors. Acceptance tests begin with the load Po, at which the initial reports of the anchor movement are recorded and brought to the value of Pu, holding it for 15 minutes, and measuring the movement of the anchor after 1, 3, 5, 7, 10 and 15 minutes, then the load is reduced to a value Ro, measuring the elastic displacement of the anchors, increase the load to the blocking Pb and fix the anchor to the structure.

The bearing capacity and test loads of the receiving anchors are defined as the minimum value of the test results from at least two nearest test anchors.

Quality assurance for the manufacture of ground anchors includes The manufacture of ground anchors should be carried out by organizations with at least 5 years of experience in geotechnical work, in which a quality assurance system is organized [2], which must be confirmed by a certificate of conformity.

At the same time, the manufacturing should inspect : a) the planned-high-altitude binding of ERT bore-injection piles; b) diameter and depth of wells for compliance with the project; c) the type of soil at the base of the anchor and its compliance with the accounted design (based on residues on the elements of the drilling tool at the base); d) compaction of soil at its base, destroyed by a drilling tool; e) compliance of the anchor frame with the project (length, diameter and class of reinforcement of working rods, joints of the rods) and the depth of immersion of the frame into the well; f) the quality of the prepared cement slurry (material consumption); g) difficulties in immersing the anchor frame under its own weight into the well (free immersion of the reinforcing frame to the design mark indicates the absence of soil pinching in the well and guarantees the continuity of the root trunk); h) immersion of the electrode system; consumption of cement slurry used in the production of ERT anchors: 1) when filling the well; 2) when processing the root at each horizon; 3) the total consumption of cement slurry for each well.

The control of the strength of the cement slurry is carried out according to [3] and [4] by taking samples of the cement slurry at the place of its manufacture and subsequent hardening under normal conditions that meet the requirements of clause 2.3.2 [4].

Hidden works survey certificates are drawn up in the form stipulated in the updated SNiP 12-01-2004 “Organization of construction”, should be drawn up for the completed process (anchor), performed by an independent subdivision of performers (complex team) during the shift [5].

It is not allowed to execute subsequent robots in the absence of formalized acts for hidden robots for completed technological processes for the production of ERT anchors that have not been certified by the technical supervision of the customer.

The works are carried out in accordance with, and the project for the production of works (PPR) [6-12].

The quality of the main materials is determined by the requirements of the town planning code and the Law on Technical Regulation, which must be confirmed by certificates of conformity, the state standard of the Russian Federation.

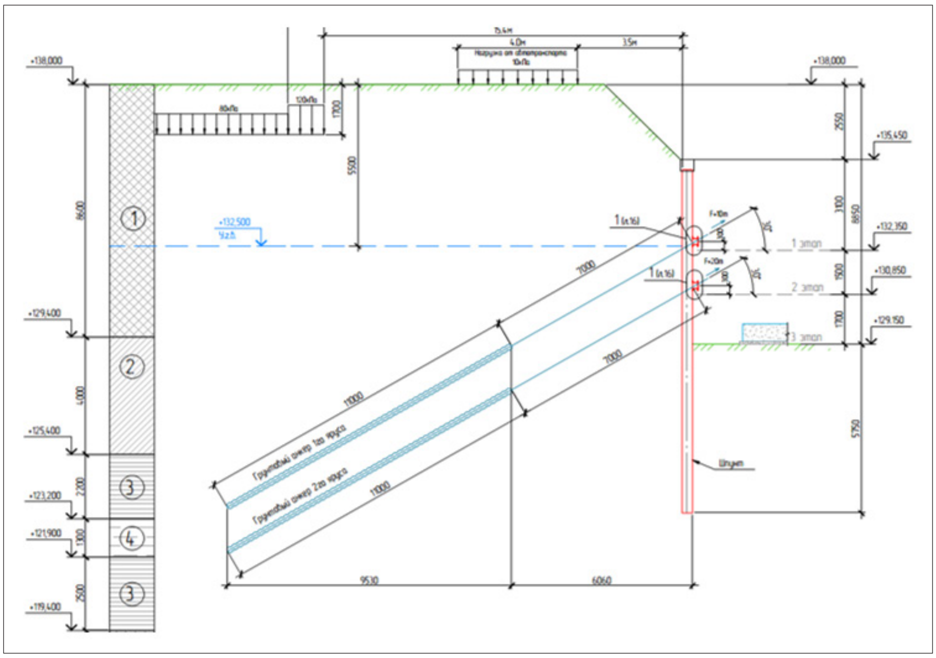

Figure 3: Arrangement of pit fencing using ground anchors.

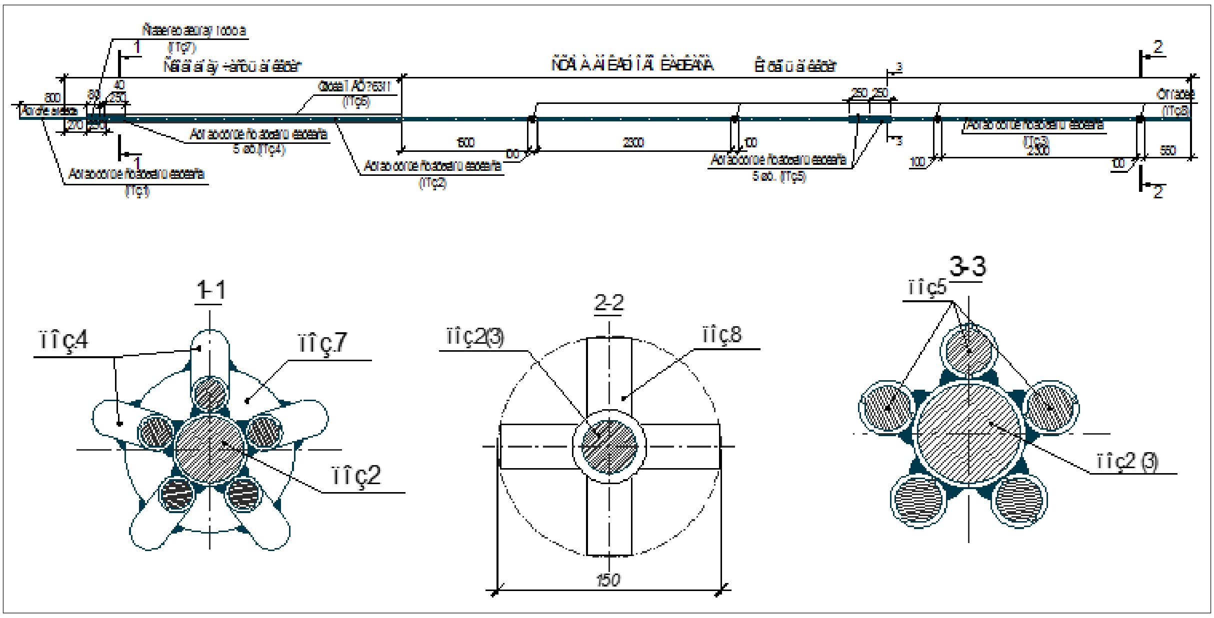

Figure 4: Scheme of the anchor frame

Conclusion

Difficult engineering and geological conditions in combination with rugged relief, unstable slopes are problem areas for their construction development. For modern geotechnical construction of facilities there is a technical and technological potential for the design and construction of facilities of any complexity [13-19].

One of the technological methods considered in the article to ensure the stability of a landslide slope is a confirmation that it is possible to carry out construction under any engineering-geological conditions.

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