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Geotechnical Practice of Slope Reinforcement

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ABSTRACT

Geotechnical construction is one of the most important branches of the construction of zero parts of objects for various purposes. The existing rich potential of geotechnical technologies allows us to successfully perform the tasks of building foundations for buildings in any engineering and geological conditions and on any territory, including slopes, ravines, embankments. Very often there are cases of erection of objects on rugged territories with alternating structurally unstable soils, moreover, additionally loaded with artificial leaning slopes. In geotechnical practice, there are still cases of construction on such slopes without proper engineering and technical support, i.e. without the presence of actually carried out engineering surveys, as well as developed anti-landslide measures. Ultimately, in most cases, the neglect of generally accepted standards leads to undesirable consequences, expressed in deformations of the constructed buildings. This article considers one such case.

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The construction of facilities in territories that are not suitable for the construction of facilities without their preliminary preparation has recently become of no small importance. Often builders neglect the concepts of sustainability, reliability of engineering-geological conditions. At the same time, when planning construction on unstable foundations, especially on leaning slopes, they make the most mistakes, which ultimately lead to a significant increase in the cost of the object. So, for example, when erecting objects on such construction sites, it is necessary to take into account both the reliability of the slope and the reliability of the embankment itself, on which the object will be placed.

During the construction of the retaining retaining wall and the erection of a sandy semi-embankment with the placement of the building of the operator and engineering infrastructure of the gas station on it, deformations and settlements of the foundations of the foundations of the operator's building and the canopy occurred. To identify the causes of deformations at the site of the reconstructed gas station No. 119, GIIZ LLC performed work at the facility: "Control drilling for the reconstruction of gas station No. 119, Chuvash Republic, Cheboksary, Shevchenko St., 8 "a". The purpose of the survey was obtaining engineering-geological data to determine the causes of deformation of the semi-embankment with the platform of the gas station being reconstructed, located on a landslide slope, and developing recommendations for their prevention (see Table 1 below).

It should be noted that prismatic driven piles were used to reinforce the bases of the foundations of the control room buildings and the canopy (see Fig. 1, 4, 5). Moreover, the piles are located in under compacted bulk soils. These piles do not participate in strengthening the foundation at all. The designers made a gross mistake by not embedding the lower ends of the piles into a reliable engineering-geological element. The ongoing process of deformation of objects speaks of this.

Table 1

№№ p / p	Tasks of engineering-geological surveys
1	Collection and analysis of materials from previously completed engineering surveys
2	Identification and mapping of the location of areas of distribution of hazardous engineering-geological processes in the survey area
3	Study of the geological and lithological structure of the survey area
4	Study of the hydrogeological conditions of the survey area
5	Study of the physical and mechanical properties of soils by laboratory and field methods
6	Determining the presence of specific soils and their characteristics
7	Assessment of slope stability to justify design solutions for engineering protection of the territory
8	Calculation of design landslide pressures for the design of POM.

Based on the conducted surveys, the engineering-geological structure of the site up to the depth explored by drilling of new and archival wells (40.0 m) is represented by bedrocks of the Severodvinsk and Vyatka stages of the Upper Permian (P3s + v) within the plateau - overlapped from the surface with bulk soils (tQh), on section of the landslide slope - Quaternary landslide deposits dpQ(prQp); dpQ(P3s+v) and fragments of the embankment (tQh), and in the floodplain - alluvial deposits of the river. Trusikha (aQh-p) - on the site of the old channel planned by man-made embankment (tQh).

According to laboratory tests, taking into account the geological structure and lithological features of soils and in accordance with GOST 25100-2016 "Soils. Classification" and 20522-2012 "Soils. Methods for statistical processing of test results", 15 engineering-geological elements (IGE) were identified at the studied sites. Below in table. 2 shows descriptions of engineering-geological elements. According to the results of the research, two EGEs were identified - bulk soils. These are IGE No. 1 and IGE No. 2. These are uncompacted layers - not compacted, represented by fine sands from loose composition to medium density, also loamy with clay interlayers.

Engineering-geological elements (IGE)	Name of engineering-geological element	Stratigraphic indices
OWNER № 1	Bulk soils: sands are fine, dense, medium-density and loose, low-moisture and wet	(tyah)
IGE № 2	Bulk soils: light, silty and heavy loams with interlayers of clay, from rigid to hard	tyah
OWNER № 3	Loams are light and silty, soft-plastic	aKh-p
IGE № 4	Sands are fine, medium density and dense, water-saturated	aKh-p
IGE № 5	Gravel-pebble soils	aKh-p
IGE № 6	Loams are landslide, light and silty from soft-plastic to semi-solid	aKh -p
IGE № 7	Landslide, clayey and calcareous marl, very low strength	dpg(pss+v)
IGE № 8	Landslide clays, light and silty, hard and semi-hard	dpk(Pzs+v)
OWNER № 9	Silty sands, landslide, loose, medium density and dense low-moisture and wet	dpk(Pzs+v)
OWNER № 10	Silty sands, landslide, loose, medium density and dense, water-saturated	dpk(Pzs+v)
IGE № 11	Clay and calcareous marl, very low strength	CCD+V
OWNER № 12	Clays are light and silty, hard and semi-hard	CCD+V
IGE № 13	Sands are silty, medium-density and dense, low-moisture and wet	CCD+V
OWNER № 14	Silty sands, medium density and dense, water-saturated	CCD+V
EGE No. 15	Silts (loams) light and silty, hard	CCD+V

At the request of the customer, FORST Research and Production LLC (Cheboksary, Chuvash Republic) developed a working draft of anti-landslide measures using bored piles and ground anchors manufactured using ERT electric discharge technology. EDT 20.0-meter-long 40.0 degree ground anchors at 94.6 absolute are designed to provide stability to an existing retaining wall constructed of bored slope reinforcement piles. Due to the absence of spacer recessed structures near this wall, it received horizontal deformations of up to 20.0 cm. The installation of EDT anchors through a monolithic reinforced concrete strapping belt at this level made it possible to stabilize horizontal deformations (see Fig. 2, 3). The results of geodetic observations clearly show this.

Additionally, at an absolute elevation of 103.500, an enclosing anti-landslide secured retaining wall was developed from two rows of EDT bored injection piles with a mark of the lower ends of 86.550 m and EDT ground anchors 20.0 m long at an angle of 40.0 degrees (see Fig. 2). EDT piles along their tops are united by a corner monolithic reinforced concrete retaining wall with buttresses, through which EDT ground anchors are passed. These anti-landslides reinforced concrete structures serve to ensure the geometry of the leaning slope. The implementation of emergency measures made it possible to stabilize the deformations of the leaning slope, bringing them to the normative state.

At the same time, the objects built on the surface of the slope continue to deform due to insufficiently fixed base (driven piles are not embedded with their lower ends into a reliable bearing layer). At the same time, they continue to deform with a roll towards the slope. Analyzing the circuits shown in fig. 1, 4, 5, it can be seen that the existing piles are located within the thickness of bulk soils that are in an under compacted state. That is, the bearing capacity of these piles on the ground turned out to be zero. Thus, with this in mind, the existing piles with negative friction additionally load the objects under consideration.

In order to stabilize the deformation of the above-mentioned objects, EDT bored-injection piles were used with the bottom end embedded in an incompressible reliable base (pos. 2 in Fig. 1, 4, 5). EDT piles for the canopy object are arranged through the grillage between the existing piles. Due to the particular constraint on the performance of work to strengthen the base of the foundations of the control room, it was decided to install a cantilevered monolithic reinforced concrete beam, brought under the sole of the existing grillage (see Fig. 1, 4). At the same time, the beams simultaneously served as grillages over the EDT bored piles. These structures were placed under all existing grillages, thanks to which the settlements of the existing foundations of the control room building stabilized.

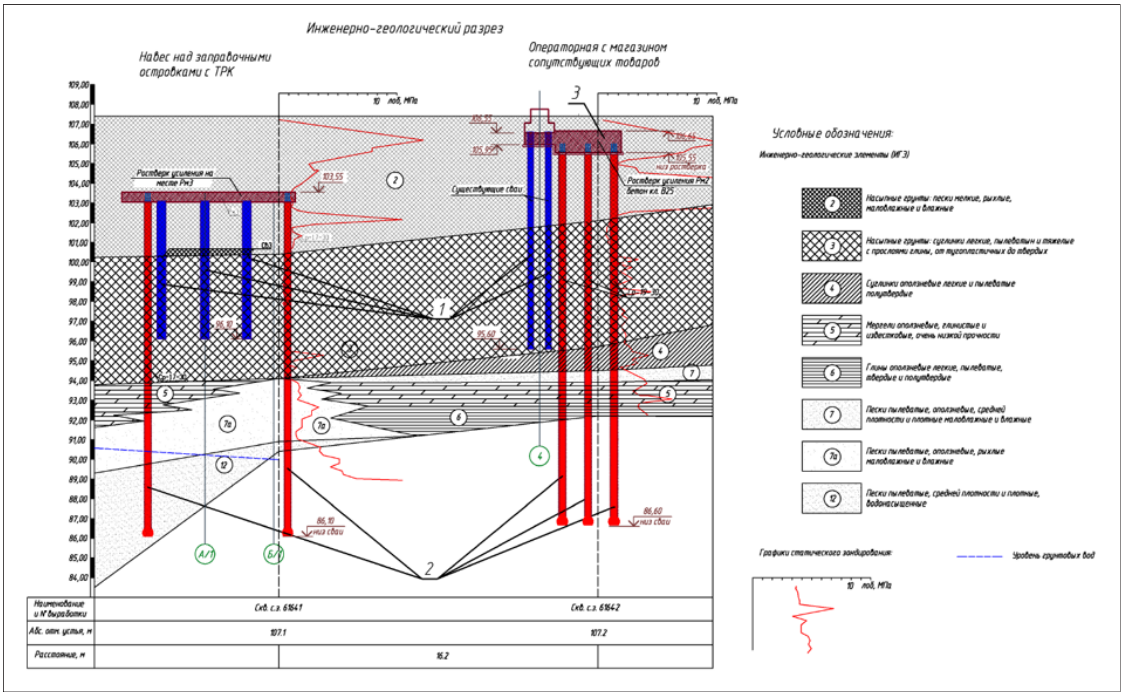

Figure 1: Engineering-geological section: 1 - existing driven piles; 2 - EDT bored piles; 3 - supplied monolithic reinforced concrete cantilever beams for existing reinforced concrete grillages

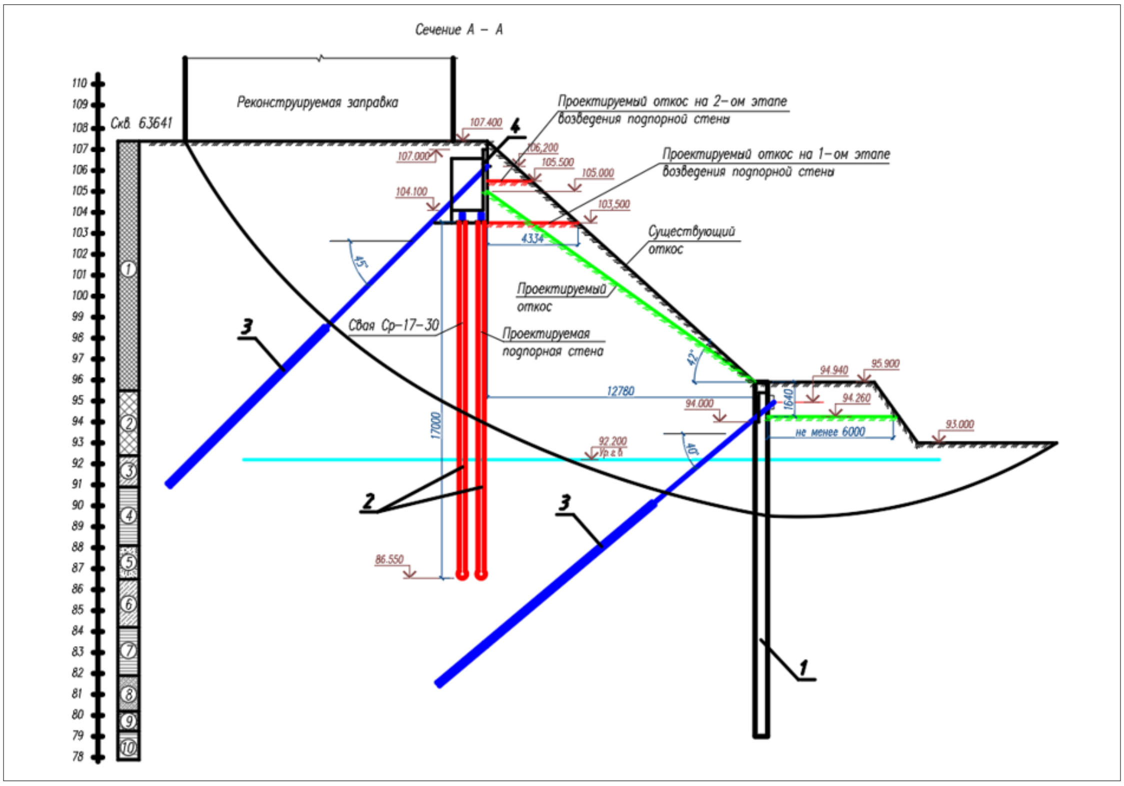

Figure 2: Cross-section of a leaning slope with anti-landslide buried reinforced concrete structures: 1 - existing retaining wall of bored piles with a diameter of 500.0 mm; 2 - EDT bored piles to reinforce the base in two rows; 3 - ground anchors ERT slope reinforcement; 4 - monolithic corner reinforced concrete retaining wall.

Figure 3: Photograph of the anchoring of the deformed slope on the landslide slope at the absolute elevation. 94.60: 1 - ground anchor; 2 - anchor strapping belt; 3 - corner monolithic reinforced concrete retaining walls.

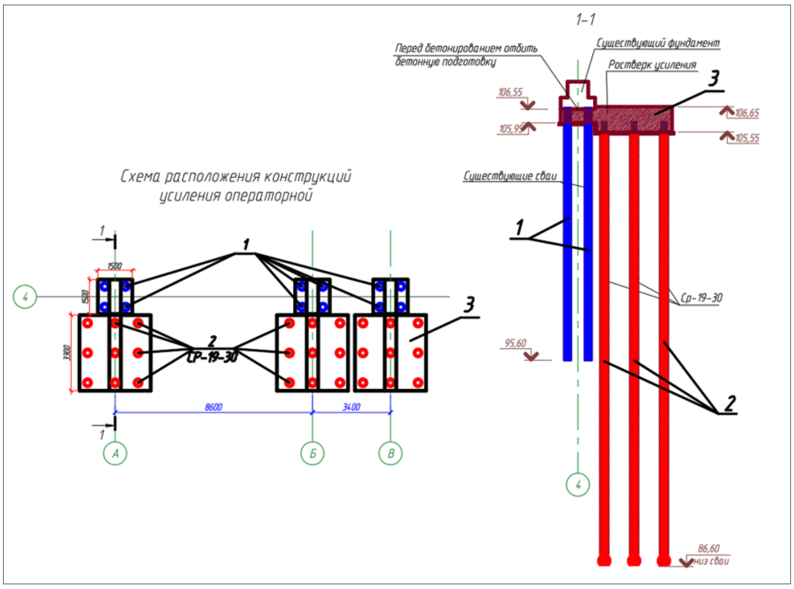

Figure 4: Scheme of strengthening the base of the foundations of the operator room: 1 - existing driven piles; 2 - EDT bored piles; 3 - supplied monolithic reinforced concrete cantilever beams for existing reinforced concrete grillages.

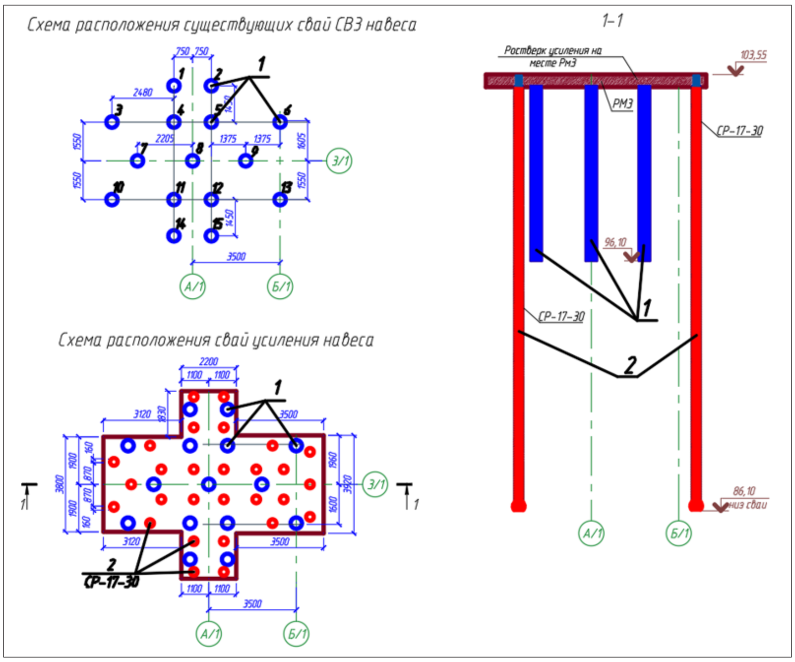

Figure 5: Scheme of strengthening the base of the canopy foundations: 1 - existing driven piles; 2 - EDT bored piles.

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