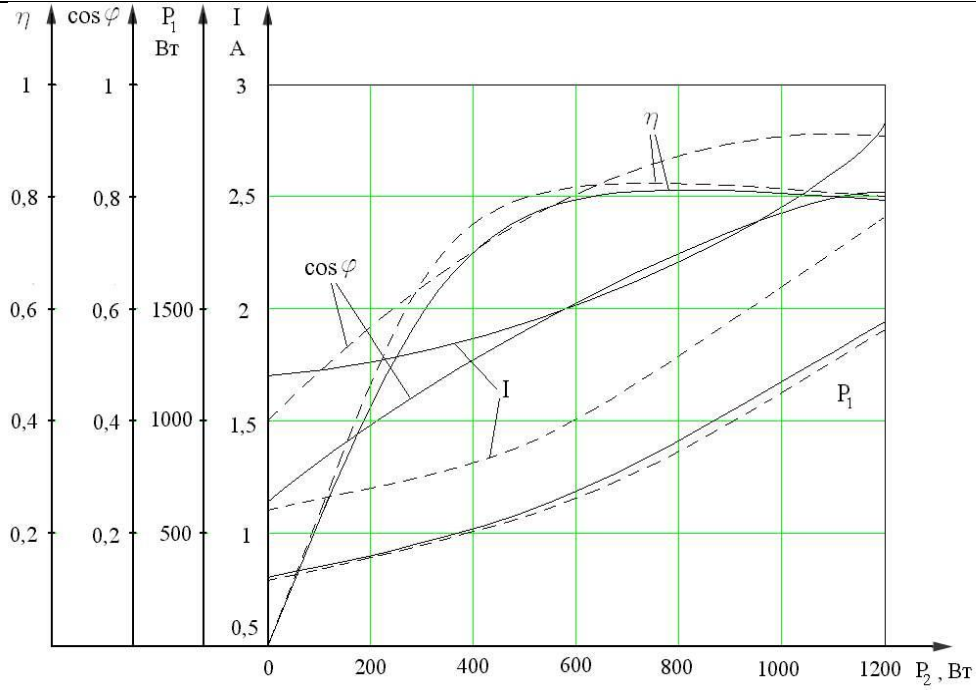

Рис. 3 – Робочі характеристики асинхронного двигуна:
——— – базового; – – – – з використанням внутрішньої ємнісної компенсації

Висновки і пропозиції

Запропонований спосіб внутрішньої ємнісної компенсації реактивної потужності асинхронних двигунів є простим, дешевим і надійним, а також він дає можливість в компенсованому асинхронному двигуні відносно серійного збільшити ККД на 10-30%, а cos φ на 7-20% при зниженні робочого номінального струму на 10-12% при деякому збільшенні пускового моменту в залежності від навантаження. Такі результати забезпечуються при використанні конденсаторів ємністю 8-12 мкФ на фазу на 1 кВт номінальної потужності двигуна.

Список літератури:

1. Лут М.Т., Синявський О.Ю. Зниження втрат енергії в асинхронних електроприводах. Енергетика і автоматика. – 2013. - №3. – С.144-149.

2. Гайдукевич С.В., Антонів О.С. Підвищення енергоефективності асинхронних електродвигунів // Вісник ХНТУСГ. Випуск 203 "Проблеми енергозабезпечення та енергозбереження в АПК України". – Харків: ХНТУСГ, 2019. – С. 117-119.

3.Акимов Н.И., Ильин В.Г. Прогрессивные способы ремонта с.х. техники. – М: Колос, 1984 г., - 380 с.

4.Большов М.М., и др. Охрана труда в с.х. – М.: Колос, 1984 г., - 624 с.

5. Пястолов А.А., Ерошенко Г.П. Эксплуатация электрооборудования. – М.: Агропромиздат, 1990 г., - 287 с.

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EXPERIENCE OF PERFORMANCE OF THE HORIZONTAL ANTI-FILTRATION SCREEN WITH THE APPLICATION OF DOUBLE FLUID JET GROUTING

Summary. The technology of jet grouting is based on the high-speed injection of one or more liquids (solution, air, water) into the ground. Fluids are injected through small-diameter nozzles located on a hydraulic monitor, which, in normal use, first drills a well to the bottom of the future soil-cement element, and then rises to the surface of the soil, performing continuous processing [1].

The type and physical and mechanical properties of the soils in which the jet-grouted element is performed will be one of the main factors that affect the geometric size of the elements and the strength characteristics of the soil-cement material.

The high anti-filtration property of the soil-cement material of elements made by the get grouting technology allows creating a wide range of vertical and horizontal waterproofing screens and barriers.

This article discusses the experience of creating a horizontal soil-cement anti-filtration screen together with a retaining structure that was made using the "diaphragm wall" technology. A feature of the object is its territorial location - in the floodplain of the Svisloch River in the city of Minsk, and the scale of construction work - more than 9000 jet-grouted columns using double fluid jet grouting technology were performed to execute the screen.

Key words: anti-filtration screen, double fluid jet grouting technology, soil-cement column, jet-grouted element.

Introduction. Due to the low water permeability (based on the research of O.A. Makovetsky [1], the filtration coefficient is 1.4-1.6*10^{-6} cm/s), the soil-cement material is used for vertical and horizontal anti-filtration screens, waterproofing barriers for dams of various types, permanent and temporary diaphragms.

When retaining structures from intersected piles or using the “diaphragm wall” method under conditions of a high level of groundwater, the bottom of such structures is buried in waterproof soil to prevent seepage of groundwater into the excavation area during excavation and, as a result, pit flooding. But in the absence of natural waterproof soil, one of the most common methods is horizontal impervious screens made adjacent to the building envelope (Fig. 1).

The main advantages of using jet grouting technology to create anti-filtration diaphragms are not only low water permeability of soil-cement material, but a wide range of soil conditions for applying the technology, high speed of work, the ability to perform work in tight working space and, most importantly, the implementation of soil cement elements to a given depth with control of geometric and strength parameters.

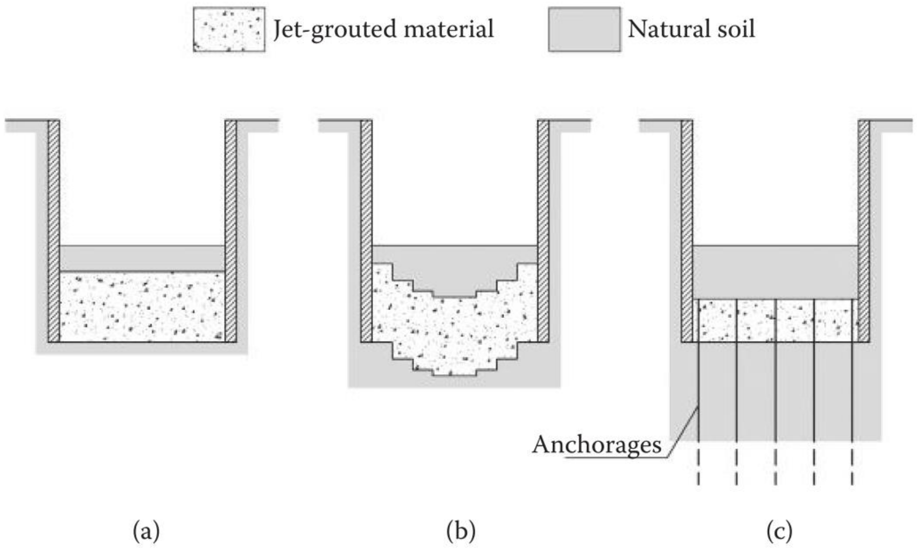

Figure 1. Types of schemes for performing horizontal screens using jet grouting technology: (a) horizontal slab, (b) inverted arch, (c) anchored slab [2].

Performing secant jet-grouted columns, a continuous horizontal screen is created, which has high strength and anti-filtration characteristics, of a given thickness with full adjacency to any type of retaining structure.

It is widely known in world construction practice to use soil-cement anti-filtration structures: the implementation of a horizontal anti-filtration screen during the construction of the Tukaya Square metro station in Kazan, described by A.G. Malinin [3]; construction of a pit fence in water-saturated sands near the river in Moscow [4]; during the construction of tunnels in Singapore [5], horizontal soil-cement screens were carried out together with a sheet pile fence and others.

Statement of the main material. A striking example of a horizontal anti-filtration screen is the "Multifunctional complex with the Kempinski Hotel" in Minsk, in the quarter of Independence Ave. - Y. Kupala St. - Svisloch River ".

According to the project for the construction of the complex, it was necessary to excavate to a depth of 6.5 m.

In 2011, the designers of JV Osnova-Solsif designed retaining structure made using the "diaphragm wall" method because of the high level of groundwater (1.5 m from the ground) and the territorial location of the construction site in the floodplain of the Svisloch River. The design of the retaining structure had a closed circuit (Fig. 2) and dimensions in the plan of about 167 m per 100 m. To avoid seepage of groundwater into the pit, since the bottom of the diaphragm wall was not brought to natural waterproof soil due to the lack of it (ground the thickness was sandy soils), a project was developed to arrange a horizontal anti-filtration screen made of soil-cement elements using the technology of two-component jet grouting.

The two flows used are air and cement solution in double fluid jet grouting technology with air. Destruction and cementation of the soil, as in the single-fluid technology, occur through a solution jet supplied under a pressure of several tens of MPa, but the ring-shaped stream of air, supplied separately under a very low pressure (several hundred kPa) from the compressor, helps the erosion function of the solution monitor. A stream of compressed air maintains the speed of the stream of solution with distance from the nozzle. It is assumed that it creates a shell around the jet of solution and protects against friction.

Air is supplied at a very high flow rate (a lot of m^3/min) and draws the soil to the surface under the influence of airlift at a considerable speed (much more than in a single-fluid technology). It can be assumed that the rapid removal of the soil with air to the surface will reduce the force that the jet must exert in order to cross the spoil in the already treated space, and that this air-lifting effect is indirectly involved in increasing the radius of action between a single jet and a double jet.

The success of using jet grouting technology depends on the correct selection of technological parameters in accordance with the engineering and geological conditions.

Before starting work in Minsk, experimental columns were made using double fluid jet grouting technology in similar ground conditions (water-saturated sand) in Kiev to adjust operating parameters (Fig. 3). The main parameter affecting the formation of a soil-cement column is the speed of rotation and elevation of the hydraulic monitor.

The process of raising the hydraulic monitor can be carried out smoothly, but it is preferable to carry out it in steps: in clay soils, the step height should be small, while in sandy and gravel soils the monitor can be raised with a large step. Therefore, in accordance with the selected monitor raising speed and step height, the jet (or jet, with several nozzles) performs a number of turns at the same height in accordance with the rotation speed.

$$t_{raising} = \frac{t_{step}}{h_{step}} \quad (1)$$

where h_{step} - step height, cm; t_{step} - time to step, s

Three sets of technological parameters with the following time spent on a step: 24, 30, and 40 s were selected to perform experimental soil-cement columns.

According to the test results, columns with diameters of ≈1500, 2000 and 2500 mm were obtained, respectively, to the changed time for the step of lifting the hydraulic monitor. The graph (Fig. 2) shows a regular dependence of the increase in the diameter of the soil-cement column on the time of soil treatment with a high-pressure jet. It can also be noted that the curve tends to horizontal alignment - this means that if the rotation time of the hydraulic monitor continues to increase after a certain value is reached, the diameter will not increase if parameters such as jet pressure, solution flow rate or the use of three-component technology instead of two-component technology are not changed.

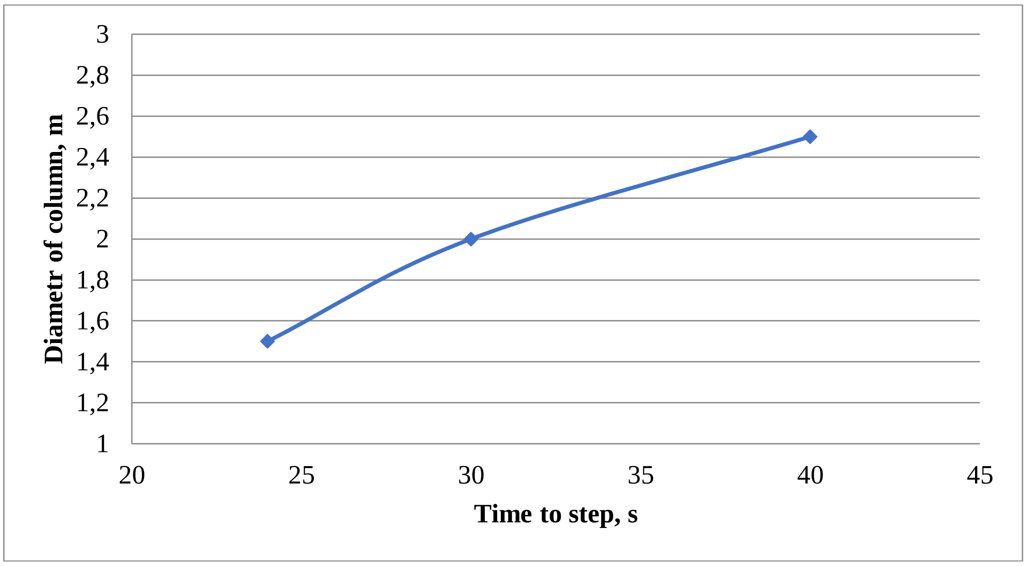

Figure 2. The dependence of the diameter of the column on time to step

The data obtained made it possible to select the appropriate operating parameters to obtain the required diameter of the columns to create a horizontal anti-filtration screen.

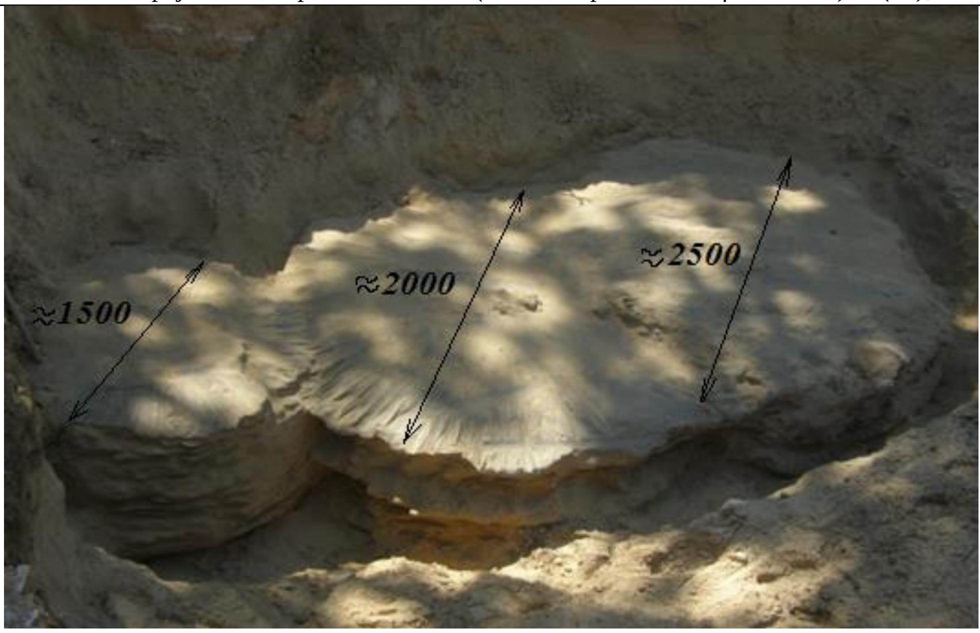

Figure 3. Experimental jet-grouted columns

In 2012, after the construction of the diaphragm wall was completed, work began on the creation of an anti-filtration screen.

A horizontal 0.8 m thick anti-filtration screen was made of soil-cement columns that intersected each other with a diameter of 1600 mm and 1200 mm at the abutment of the screen with the diaphragm wall. The number of jet-grouted columns according to the project was 8854 pcs (ø1600 mm) and 184 pcs (ø1200 mm).

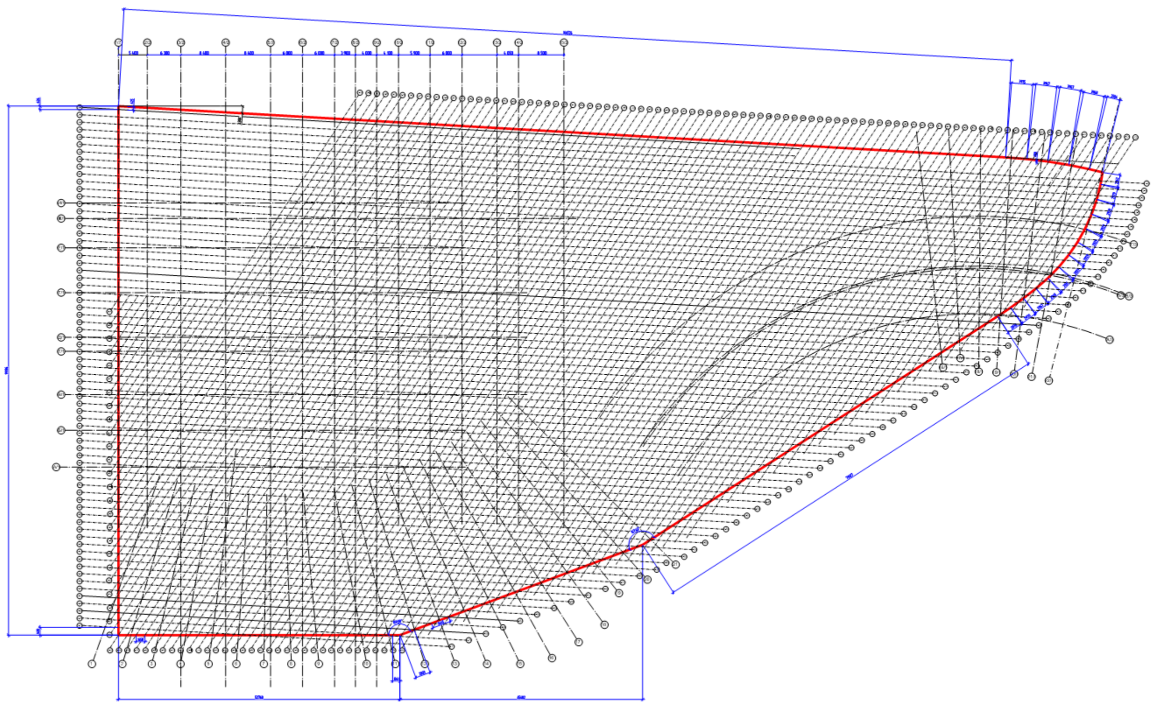

Figure 4. The plan for the diaphragm wall

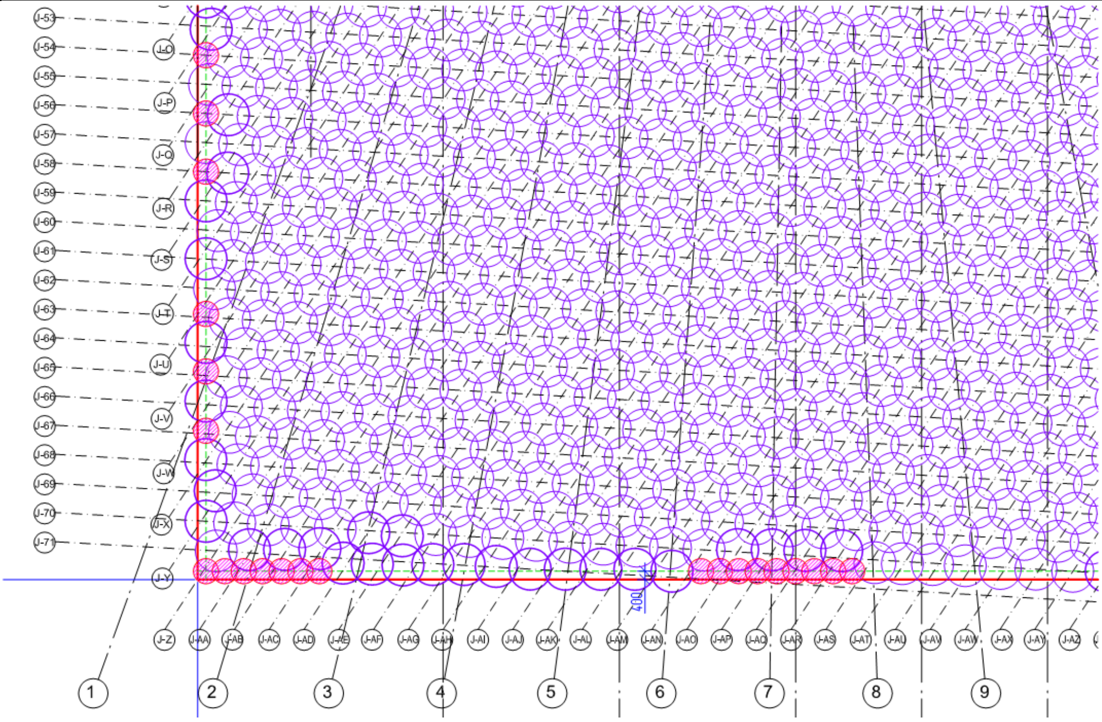

Figure 5. Fragment of the plan for the location of jet-grouted columns

Soil-cement columns were made using duble fluid jet grouting technology using cement-bentonite solution.

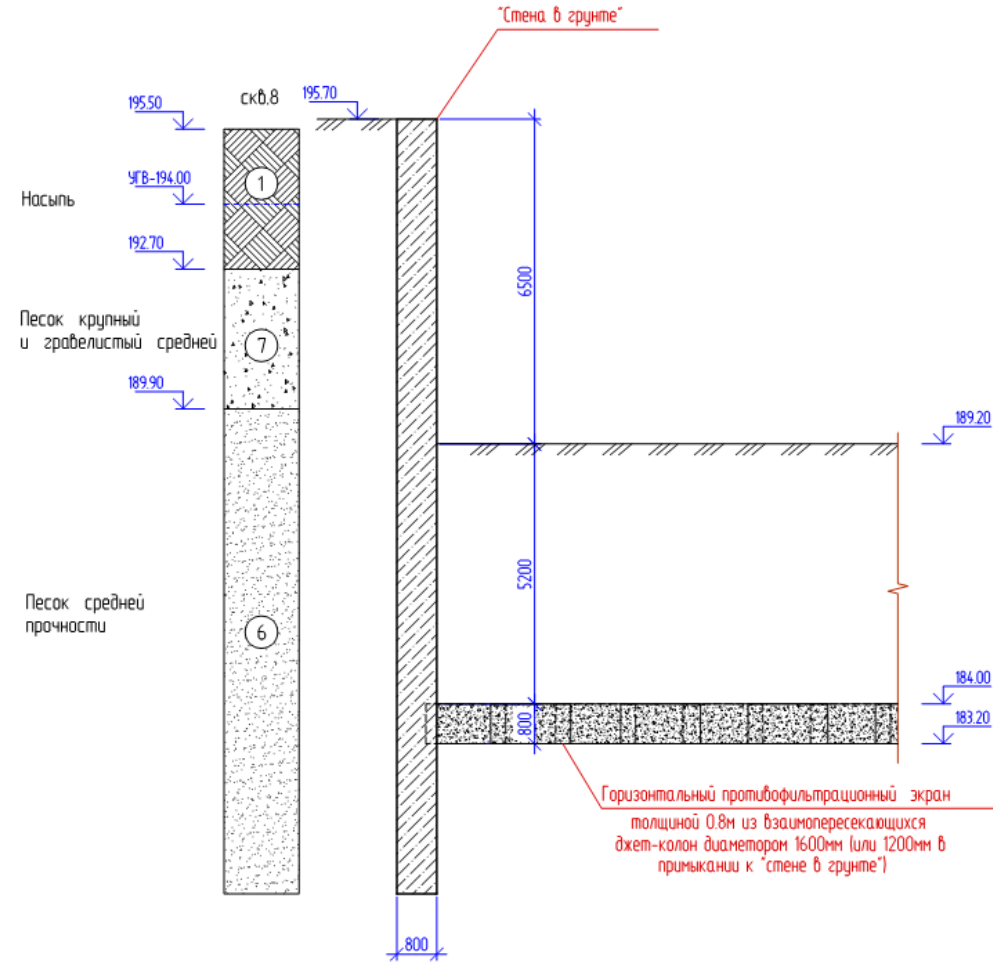

Figure 6. Cross section of the construction of the retaining wall and the anti-filtration screen.

In conjunction with the anti-filtration screen, a project for water reduction was developed. In 2012, excavation works were successfully completed. As of 2020, the Kempinski hotel complex is completed but not put into operation.

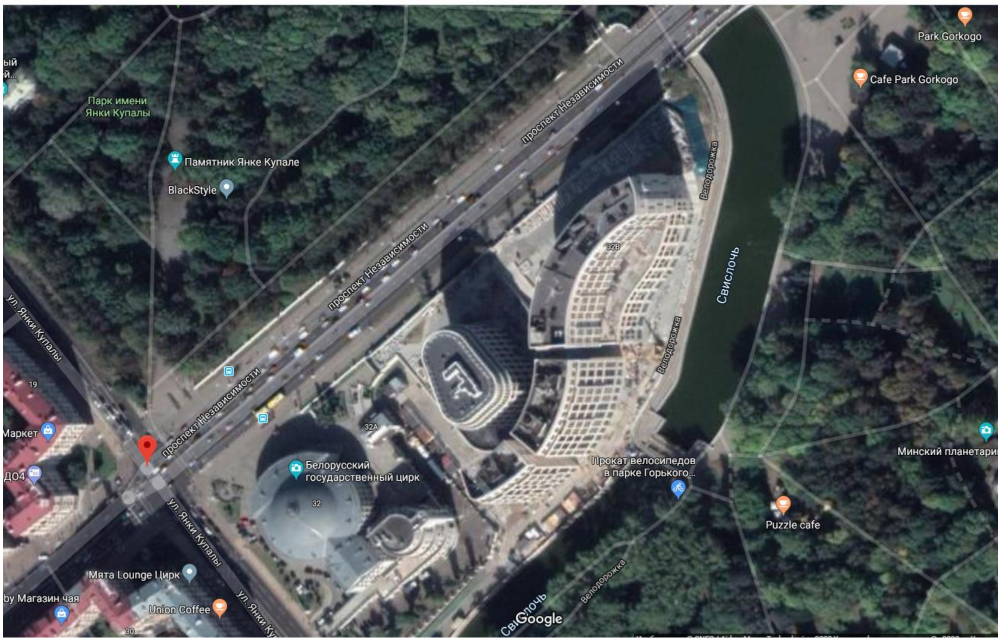

Figure 7. Multifunctional complex with the hotel "Kempinski" (Google map)

Figure 8. A multifunctional complex with the Kempinski hotel as of 2014 [6]: a) view from the street. Y. Kupala; b) view from the side of the river Svisloch

Conclusions

Due to the property of soil-cement material such as low permeability, jet-grouted elements are excellent for creating anti-filtration barriers and screens during construction in flooded soils or when using hydraulic structures as constituent elements.

The ability to perform work on jet grouting in tight working space and, most importantly, to create soil-cement elements to a given depth with the control of geometric and strength parameters, can solve almost any geotechnical problem.

According to the results of tests carried out before starting work on the construction site, the dependence of the increase in the diameter of the soil-cement column on the time of processing sandy soil with a high-pressure jet was established.

On the example of the object described in the article "Construction of a multifunctional complex with the Kempinski Hotel" in Minsk, the successful use of horizontal soil-cement screens in collaboration with a retaining structure made using the diaphragm wall technology in difficult flooded engineering and geological conditions is shown. With the subsequent application of the developed water reduction scheme, a successful excavation was performed and the underground part of the complex was constructed.

This construction site in terms of scale at that time was the first of its kind in Europe, where more than 9000 jet-grouted columns were made using the technology of double fluid jet grouting.

List of reference:

1. Маковецкий О.А., Хусаинов И.И. "Опыт применения струйной цементации для устройства подземных частей жилых комплексов" // Світ геотехніки. 2012. №4. С. 20-23. [Makovetskii O.A., Khusainov I.I. "Opyt primeneniya struinoi tsementatsii dlya ustroistva podzemnykh chastei zhilykh kompleksov" // Svit geotekhniki. 2012;(4):20-23. (In Russ)].

2. Croce P., Flora A., Modoni G. Jet Grouting. Technology, Design and Control. NW: SRS Press Taylor & Francis Group; 2014.
3. Малинин А.Г. Устройство горизонтальной завесы с помощью струйной цементации грунта. URL: htto://jet-grouting.info
4. Малинин А.Г. Струйная цементация грунтов: монография. Пермь: Пресстайм; 2007. [Malinin A.G. Struinaya tsementatsiya gruntov: monografiya. Perm': Presstaim; 2007. (In Russ)].]
5. His J.P., Yu J.B.Y. "Jet grout application for excavation in soft marine clay" // Proceeding of the 16th International conference on soil mechanics and geotechnical engineering, Osaka. 2005; 1485-1489.
6. Форум проектировщиков Белоруссии. URL: https://www.skyscrapercity.com

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ПОРІВНЯЛЬНИЙ АНАЛІЗ ПРИСТРОЇВ УКОЧУЮЧОГО РОЛИКА МЕХАНІЗМУ НАМОТУВАННЯ БОБІНАЖНО-ПЕРЕМОТУВАЛЬНИХ МАШИН

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СРАВНИТЕЛЬНЫЙ АНАЛИЗ УСТРОЙСТВ УКАТЫВАЮЩЕГО РОЛИКА МЕХАНИЗМА НАМОТКИ БОБИНАЖНО-ПЕРЕМОТОЧНЫХ МАШИН

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