UDC 624.15
DOI: 10.25140/2411-5363-2018-2(12)-290-296

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EXPERIENCE OF FIXING A WEAK BASE FOUNDATION BY VERTICAL SOIL-CEMENT ELEMENTS USING DRILL-MIXING TECHNOLOGY

Urgency of the research. Most construction sites in Ukraine have soil conditions area created by weak soils. Permanent pursuit of economical of engineering solutions require the use of new design solutions in the construction on weak soils.

Target setting. In the last years new ways to fixing base of foundations using drill-mixing technology are gaining popularity. In the process of drilling a special wing bit is a destruction of natural soil and mixing with cement solution. As a result of solidification mixture formed is solid soil-cement element.

Actual scientific researchs and issues analysis. It has been previously performed in the laboratory study of strength soil-cement vertical elements depending on the amount of cement composition "soil-cement", water-cement ratio in the mixture clay-cement additives properties. In order to a preliminary assessment of effectiveness fixing foundation using drill-mixing technology numerical simulation was performed.

Uninvestigated parts of general matters defining. Using the weak soils as the basis for foundations of buildings and structures is seen in view of the possible destruction of their structure and the development of non-uniform deformation.

The research objective. Perform evaluation of the effectiveness of fixing the building foundations on the example of a real construction site.

The statement of basic materialas. In practice fixing foundations was performed using drill-mixing technology at the construction site in the city of Kiev. The article presents data about the experience fixing of weak base foundation, composed bulk soils with the contents of construction and domestic garbage. Fixing performed by soil-cement vertical elements using drill-mixing technology.

Conclusions. The choice of a rational scheme of «basis - the foundation - over ground part of the building» should be based on an objective assessment of the mechanical properties of soil, and bearing structures of the building. Applying the basics fixing technology has allowed to reduce the cost of foundation structures up to 20 %.

Keywords: weak base; soil-cement; drill-mixing technology; base fixing; monitoring.
Fig.: 6. Table: 1. References: 7.

Urgency of the research. In the last years new ways to fixing base of foundations using drill-mixing technology are gaining popularity. In the process of drilling a special wing bit is a destruction of natural soil and mixing with cement solution. As a result of solidification mixture formed is solid soil-cement element.

Fixing by drill-mixing technology can be applied in weak soils, including sand, clay, silt and loess. This fixing enables to create constructions from soil-cement as vertical elements under foundations any construction. The vertical elements can be executed with a diameter of 0.5...1.0 m depth 10 m 25 m and solution injection pressure 1...3 MPa [1; 2].

Production work on the fixing drill-mixing technology consists of two basic steps:
- preparation of water-cement solution;
- injecting cement solution and mixing with the soil by immersion.

Actual scientific researchs and issues analysis. It has been previously performed in the laboratory study of strength soil-cement vertical elements depending on the amount of cement composition “soil-cement”, water-cement ratio in the mixture clay-cement additives properties [3].

By results of physical modeling fixing foundation in the laboratory been substantiated fixing using soil-cement elements in loamy soils during reconstruction of buildings [4].

In order to a preliminary assessment of effectiveness fixing foundation using drill-mixing technology was performed numerical simulation [5]. Considering options fixing foundations with a different arrangement of vertical elements in the plan.

Uninvestigated parts of general matters defining. Most construction sites in Ukraine have soil conditions area created by weak soils. Permanent pursuit of economical of engineering solutions require the use of new design solutions in the construction on weak soils.

Target setting. Using the weak soils as the basis for foundations of buildings and structures is seen in view of the possible destruction of their structure and the development of non-uniform deformation. Experimental records about fixing will allow to optimize the structural solution of foundation structures of buildings.

The research objective. Perform evaluation of the effectiveness of fixing the building foundations on the example of a real construction site.
The statement of basic materials. In practice fixing foundations was performed using drill-mixing technology at the construction site in the city of Kiev. There planned to build the complex of residential buildings with infrastructure facilities. The surface area of the construction site was generated in the process of engineering construction companies (soil dump, is often with remains of building structures and garbage) and waste of local industry and the activities of residents.

The investigated region refers to the southern border of Kiev. Therefore, the indigenous sediments here has accumulated water-glacial deposits of sand, sandy loam, clay loam and moraine. These soils are deposited in all territory of the area.

The development surface erosion led to the formation of ravines. In this area, the active erosion was completed. Slopes under the action natural factors were formed as resistant to landslide processes.

However, technogenic activities during the last century gradually began to influence: the bottom of the ravine was filled actively domestic waste, construction soil with waste residues of building structures and construction debris. This of course affects the geotechnical and hydrogeological conditions.

The construction of this area also lead to certain changes in his condition. According to the project allocated four lines construction of houses. Building queue is shown in Figure 1.

![Fig. 1. Plan for residential complex with allocation queue](image)

Erection of buildings started with the simplest area on ground conditions (queue I). Monitoring subsidence base of foundations residential building (queue I), erected on the sand cushion is shown in Figure 2.

Indicators of mechanical properties on the stability of the base in water saturated condition shown in Table.

| type of soil    | $\phi$, degrees | $c_l$, kPa | $E$, MPa |
|----------------|-----------------|------------|----------|
| sand           | 27...31         | 2...3      | 25...35  |
| sandy loam     | 19...21         | 11...19    | 20...22  |
| loam           | 17              | 20         | 25       |
In the surface area of the building overlie bulk soils representing the weak soils with the content construction debris and decomposing household waste. Thickness bulk layer soil up to 18 m.

*Fig. 2. Monitoring base subsidence of residential building foundation (queue I) erected on the sand cushion*

Application fixing under a slab foundation by soil-cement vertical elements using drill-mixing technology enables a whole to improve the general situation the preparation of base on available technology and has additional positive sides:

- fixing can be performed corresponding to the bottom level of ground pads of entire space so that ensures continuous improvement in the bulk soil characteristics;
- fixing indicates the possibility of its fulfillment in accordance with the technological requirements of to the desired depth, so that the thickness of the bulk layer is fully amplified;
- laboratory tests confirm that soil-cement strength increases with time, that is, over time, the reliability of fixing weakly soil increases.

Practice confirms that in time the strength in the soil massif, which is fixed, can be increased to 1.5 times [6; 7]. Diagram fixing under slab foundation soil-cement elements and location of elements shown in plan in Figs. 3, 4.

Production work on the fixing soil-cement elements using drill-mixing technology – in Fig. 5. General view performance of work is shown in Fig. 6.

To improve ecological protection organics were recommended to add bentonite in cement solution an amount of 1 % by weight of cement. Bentonite clay can actively absorb the allocating.
Fig. 3. Diagram fixing under slab foundation soil-cement elements

Fig. 4. Location of elements shown in plan

Fig. 5. Production work on the fixing soil-cement elements using drill-mixing technology
To ensure the strength of the vertical elements of critical actions (subsidence bulk soil, surrounding the trunks, will lead to the manifestation of the effect of “negative friction”), it was decided to increase the consumption of cement and 120 ... 150 kg per meter of vertical elements. Due to the increased risk, step between vertical elements, it was decided to reduce to 1.5 m.

Fixing foundation residential complex by soil-cement vertical elements using drill-mixing technology allowed to reduce cost of the work of building foundations up to 20 %. This fixing was successful and the deformation of the building being reduced did not exceed the results of monitoring of 30 mm.

Fig. 6. General view performance of work: preparation of foundation (a); the device of the foundation slab (b); the device of basement (c); building frame (d)

Conclusions. The choice of a rational scheme of “basis - the foundation - over ground part of the building” should be based on an objective assessment of the mechanical properties of soil, and bearing structures of the building. The example confirms - it is necessary deeply study the properties of soils with given their change in perspective and possible fixing, as well as to control a constructive solutions and supporting structures by means of monitoring.

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 experiences of strengthening the foundation base of vertical elements made of ground-cement mix using the technology of ground mixing. 


classified under: 

slab foundation, ground-cement mix, technology of ground mixing, foundation fixation, monitoring.

Fig.: 6. Tabl.: 1. Бібл.: 7.
ОПЫТ ЗАКРЕПЛЕНИЯ СЛАБОГО ОСНОВАНИЯ ФУНДАМЕНТА ВЕРТИКАЛЬНЫМИ ГРУНТОЦЕМЕНТНЫМИ ЭЛЕМЕНТАМИ С ИСПОЛЬЗОВАНИЕМ ТЕХНОЛОГИИ ГРУНТОСМЕШИВАНИЯ

Актуальность темы исследования. Большинство строительных площадок в Украине имеют грунтовые условия. Постановка проблемы. В последнее время популярность приобретает новый способ закрепления основания фундамента с помощью технологии грунтоцементирования. В процессе бурения происходит разрушение природной структуры грунта и перемешивание с цементным раствором. В результате твердения смеси образуется твердый грунтоцементный элемент.

Анализ последних исследований и публикаций. Ранее выполнялись в лабораторных условиях исследования прочности грунтоцементных вертикальных элементов в зависимости от содержания цемента, соотношения «грунт-цемент», водно-цементного соотношения в смеси, свойств глинисто-цементных добавок. Для предварительной оценки эффективности закрепления фундамента с использованием технологии грунтоцементирования было выполнено численное моделирование.

Выводы. Использование слабых грунтов в качестве основания фундаментов зданий и сооружений должно рассматриваться с учетом возможного разрушения их структуры и развития неравномерных деформаций. Закрепление основания выполнялось вертикальными грунтоцементными элементами с использованием технологии грунтоцементирования.

Ключевые слова: слабое основание; грунтоцемент; технология грунтоцементирования; закрепление основания; мониторинг.

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