CONSTRUCTION OF BUILDINGS AND STRUCTURES IN DIFFICULT GROUND CONDITIONS AND SEISMIC AREAS

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Annotation. This scientific article is devoted to methods of preparation of loess bases of buildings and structures in difficult ground conditions, in particular in seismic areas. A recommendation has been developed for compacting loess subsidence soils of the bases of low-rise buildings and bulk soils around the Foundation with vibratory rollers in difficult ground conditions, in particular in seismic areas.

Key words: loess soils; clay soils; complex soil conditions; deformation; seismic areas; foundations; designed; methods; compaction; vibration compaction; vibration roller.

1. Introduction. During the construction of buildings and structures on weak water-saturated clay, swelling, bulk, saline, macroporous subsidence loess, as well as in other difficult ground conditions, precipitation and subsidence of the foundations of buildings is significantly greater than allowed for this type of structures. Ground conditions in seismic areas also refer to difficult ground conditions.

Also, difficult ground conditions in the construction of buildings and structures can include bases that consist of soils with unusual properties, or bases in the thickness of which there are recesses, voids, cavities filled with water, ice or gas. When designing and constructing buildings and structures on such sites, in most cases it is necessary to arrange an artificial foundation and change the design of buildings and structures to increase their rigidity. In order to ensure the normal operation of such structures, special design measures are used: in particular, cutting buildings and structures with sedimentary seams, devices of monolithic slab foundations or monolithic foundations made of cross reinforced concrete tapes, devices of inter-storey reinforced concrete binding belts [1,2].

The design and construction of buildings on weak clay, subsident loess soils in areas subject to frequent seismic impacts with the provision of trouble-free operation is one of the complex problems of modern earthquake-resistant construction.The difficulty of this problem is caused by the specific properties of moistened weak clay and subsident loess, one of the most seismically unstable soils, capable of producing subsidence measured in several tens of centimeters, and sometimes meters, both from additional moisture and from vibration. An additional drawdown in an earthquake can have a significant value exceeding 2-3 times the usual drawdown. These circumstances, along with other factors, lead to catastrophic phenomena associated with the death of a large number of people during earthquakes [3-6].

The importance of studying the phenomenon of additional deformation is dictated by the need to assess and prevent possible damage to buildings erected on weak clay and subsident loess soils in seismic zones, as well as by analyzing the consequences of earthquakes.

2. Literature Review. The works of H.B.Sid, Z.Bazant, N.N.Ambraseis, B.H.Faulconer, J.K.Minami, F.Mogami, N.M.Gersevanov, N.N.Maslov, M.Y.Abelev, V.A.Ilyichev, S. were devoted to the methods of construction of buildings and structures on weak clay and subsident loess soils.B.Ukhova, P.A.Konovalova, V.I.Krutova, E.A.Sorochana, H.Z.Rasulov and others.

Numerous analyses of the causes of deformation of buildings and structures located on weak clay and subsident loess soils have shown that they are characterized by three main features that must be taken into account when designing buildings and structures [2]:

- high compressibility of soils, leading to very large precipitation of buildings and structures located on them, and as a result of deformation and accident of structures;
- their low strength, low shear resistance values, as well as the difficulty of ensuring the stability of foundations and entire buildings and structures on the soils under consideration;
- long duration of precipitation of buildings and structures, sometimes reaching several decades.

In difficult soil conditions, it is necessary to take into account when conducting studies of bases composed of subsident loess soils, weak clay soils, bulk soils, that after a while all the soils of the base will become water-saturated.When designing buildings and structures, it is necessary to carry out calculations of foundations in difficult ground conditions of natural soil moisture and for fully water-saturated soils.

Insufficiency, as well as poor quality of engineering and geological surveys, are often the reasons for erroneous design decisions on foundations and foundation structures. In difficult ground conditions, when designing foundations and foundations, it requires high and special qualification of designers.

It is often necessary to give a forecast of the behavior of foundations with a score greater than 9 and to estimate possible precipitation. In areas with a seismicity of more than 9 points, a more detailed study of the properties of soils under intense dynamic impacts is necessary.

Currently, the foundations of the main types for the most common ground conditions can be designed taking into account the seismic resistance of structures with high technical and economic indicators. However, with the development of seismology and earthquake-resistant construction, builders face new challenges, especially in connection with the need to erect structures in areas previously considered unsuitable for construction.

3. Materials and methods. The share of the cost of foundations in seismic areas is relatively higher than the share of the cost of foundations of similar buildings and structures in non-seismic areas.After the construction and commissioning of unique buildings and structures erected in difficult engineering and geological conditions (in areas of landslide and karst processes, on weak clay, subsident loess, swollen and highly saline ground, as well as highly seismic areas), stationary observations are conducted for changes in the geological environment. At the same time, observations are carried out for deformations (seismic subsidence, subsidence, precipitation, swelling, displacements,

etc.), for the regime of groundwater (rise of the groundwater level, changes in the chemical composition of the soil, etc.), for the movement of slopes, etc.

These materials obtained make it possible to adjust forecasts that will be given in similar natural conditions at new construction sites, as well as to improve the methodology of engineering and geological surveys.

The main direction of modern foundation construction in difficult ground conditions is to refine the methods of survey and design of foundations and to develop new technological methods for the construction of artificial foundations and the construction of economical foundations.Labor costs often reach up to 15-20%, and the consumption of concrete and reinforced concrete is up to 24% of its total consumption in construction.

It is known that the main constructive measure in the construction of buildings and structures is the use of reinforced concrete and metal belts. As you can see, there is some overspending of metal, but significantly reduce operating costs. It is known that the rigidity of buildings increases significantly with the installation of reinforced concrete belts, which are laid continuously at the floor level, and when a significant increase in the rigidity of the building is not required, it is possible to install reinforced concrete belts at the basement floor level and at the floor level of the penultimate floor. Industrial and civil buildings constructed of brick with reinforced concrete belts allow precipitation 3-5 times greater than panel or block buildings.

In difficult ground conditions, when designing and constructing multi-storey buildings and structures with a large length, sedimentary seams should be arranged, which should separate the multi-storey parts of the building from each other and divide the buildings into rigid blocks with small dimensions. Sedimentary seams are arranged in buildings of great length, taking into account the engineering and geological structure of the site, as well as in places where the thickness of the layer of weak clay and loess subsidence soils changes, in places where one type of soil is replaced by another with different deformative indicators.

The design of deep foundations or the use of pile stands is the most effective with measures that reduce the capacity of weak clay and loess subsidence foundations of buildings and structures.

When constructing buildings and structures on weak clay and loess subsidence soils, deep foundations are used in construction practice very often, and they are suitable for any buildings and structures.

As it is known, the construction of deep foundations is practically not associated with special difficulties and does not require large material costs, and at the same time it becomes possible to build basements without significantly increasing the cost of construction as a whole. With a significant deepening of the foundation, the overall degree of its stability increases, as more favorable conditions are created for the perception of the load from the building. In this case, it is possible to use a more significant thickness sealing capacity in the lateral zones bordering the structure as a priming.

Sometimes such weak clay and subsident loess soils lie at the base of buildings that the necessary degree of stability of the building cannot be provided by a number of methods, in particular by deepening the foundation. Then the transfer of the load from the structure to stronger, deeper layers that cut through weak soils, in many cases is solved in the simplest way-by using piles-racks.

The use of deep foundations and pile foundations can reduce the power of weak soils and lower the estimated score of the construction area of the projected buildings.

As noted earlier, the ground conditions in seismic areas also relate to difficult ground conditions. Professor H.Z.Rasulov's proposed method of "earthquake-resistant foundation" makes it possible to quantify the increments of the construction site's score in each specific case, taking into account the strength of the underlying soils, the weight of buildings, as well as the intensity and nature of the expected earthquake. The advantage of the "earthquake–resistant foundation" method is simplicity and comparative accuracy. When calculating it, no additional costs are required. Work on determining the parameters of shear resistance can be carried out by engineering and geological expeditions and construction organizations engaged in the design of buildings and structures. The use of the "earthquake-resistant foundation" method makes it possible for the designer not only to determine the score of the construction site, but also to take it into account in quantitative terms in calculations using the calculated value of the seismicity coefficient [3].

4. Results and Discussion. The design and construction of buildings and structures on weak clay and subsident loess soils, in seismic areas with ensuring their strength, stability and reliable operation is one of the complex problems of modern construction.

The study of the causes of deformations of buildings and structures erected on weak clay and moistened subsidence loess soils under seismic influences shows that uneven subsidence of the foundation and deformation of the erected structures also occurs with minimal pressure on the ground, and the nature of the deformation of the structure depends on ground conditions and the intensity of seismic activity [7,8]. A typical example of this is the consequences of the Gazli earthquakes (Uzbekistan) of 1976, 1984, when not only 2-storey panel and brick houses were completely destroyed, but also lighter, including wooden structures, i.e. damage to buildings and structures occurred regardless of the specific pressure transmitted to the base and the power of the active (compressible) zone [3,4].

Thus, in the presence of weak clay and subsident loess soils capable of transitioning into a dynamically disturbed state, it is not always possible to ensure the strength and stability of structures by calculating their bases according to the first limit state (bearing capacity).

In this regard, there is a need to develop a new design principle based on the conditions of joint work of the entire structure as a whole with the foundation, i.e. taking into account the strength characteristics of the foundation soils, the specifics of the work of the building structure.

One of the most reliable methods to ensure the strength and stability of the operation of structures, the assignment of the calculated pressure on the base and the calculation of the limitation of the value of the average precipitation and the resulting difference in the precipitation of individual neighboring foundations, would be compliance with the condition when the critical acceleration is greater than the seismic acceleration, if this condition is not met, i.e. when the critical acceleration is less, than seismic acceleration, when assessing the bearing capacity of the base, a decrease in the strength of the soil during shaking should be taken into account.

It is known that each type of soil, depending on its composition, condition and properties, has its own critical acceleration of the vibration of soil particles. Most authors call critical acceleration such an acceleration of the vibration of soil particles, at which the soil is in a state of extreme equilibrium and a slight excess of acceleration against the critical acceleration is sufficient for the water-saturated soil to pass into a state of loss of its dynamic stability, i.e. into a state of “liquefaction”. As a result of liquefaction, the structural strength of the soil decreases in the development of significant plastic deformations both in the soils lying in the zones bordering the foundation and in the subfundament zone of the foundation, leading to unacceptable deformations of the structure itself [9-15].

Conditions when critical acceleration is greater than seismic acceleration can be achieved by increasing the strength characteristics of soils. One of the ways to increase the strength characteristics of soils is their compaction.

Currently, compaction is carried out by one of the well-known methods: using static rollers, heavy rammers, vibration compaction, etc. Based on the conditions of the problem, the greatest interest for our research is vibration compaction by rollers. Vibration compaction by rollers is widely used in the practice of hydraulic engineering and road construction.

The method of vibration compaction by rollers is the most economical and effective, especially for compacting the soils of the foundations of low-rise buildings and bulk soils lying around the foundation. This ensures the creation of appropriate strength of weak clay and subsident loess soils and in the lateral zones of the foundation and contributes to the elimination of seismic subsidence phenomena, respectively, increasing the value of critical accelerations in the zones under consideration. The mass application of this method in the practice of construction on weak clay and subsident loess soils in seismic areas, however, requires additional formulation of laboratory and field experimental studies and its theoretical justification for solving the problem [9-12].

We have developed recommendations for vibration compaction of foundations and bulk soils around the foundation give a good result in the plan under consideration for structures characterized by a load intensity up to P = 0.15-2.0 MPa.

In accordance with the difference in the objects of vibration compaction, these recommendations include the following two sections: vibration compaction of the foundations (the bottom of the pit); vibration compaction of bulk soils stacked in layers around the foundation.

In order to achieve the required density of soils in the basement part of the foundation, it is necessary to comply with certain requirements for soils of undisturbed structure. Such requirements for the construction of buildings and structures are set out in the general rules of excavation.

Backfilling of trenches and sinuses of pits are made, as a rule, from local soils obtained when the pit is torn off. At the same time, the regulation of the thickness of the backfilled layer, based on the required density, in comparison with the soils of an undisturbed structure does not seem difficult.

For the purpose of concreteness, these recommendations are formulated in the form of separate paragraphs, accompanied, if necessary, by appropriate notes.

5. Conclusions. It should be noted that the method of compaction of soils using vibratory rollers is an effective and accelerated method of preparing the foundations of buildings and structures on low-power loess subsidence soils. The normal operation of erected buildings and structures in areas with difficult ground conditions, in particular seismic areas, indicates the reliability of the preparation of foundations.

To achieve a given density of the soil, it is necessary to take into account its certain humidity. This is necessary to ensure its proper strength, deformability within certain limits and workability, in relation to the vibration compacting mechanisms available for construction.

When calculating the economic efficiency of the method of compaction of soils with the help of vibratory rollers, options for preparing the bases should be considered, ensuring the complete elimination of subsidence properties of soils.

Among the methods of compaction of soils that ensure the complete elimination of subsidence properties of soils, the method of compaction of soils using vibratory rollers is reliable and economical. The cost of one cubic meter of compacted soil is 2-3 times cheaper compared to surface methods of compacting soils with heavy ramming.

In conclusion, it should be noted that in the conditions of Uzbekistan, where additional deformations may occur in the foundations and around the foundations of buildings and structures during seismic impacts, the method of compaction of soils using vibratory rollers is the most reliable way to prepare the foundations of low-rise buildings and structures.

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