ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 7 , July 2019

Designing and Construction of Buildings in Complex Ground Conditions of Central Asia

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ABSTRACT: This article presents the method of vibrocompaction of wetted loess bases of buildings and bulk soils lying around the basement in difficult ground conditions of Central Asia.

KEYWORDS: subsidence, macroporous, water-saturated, bulk, swelling, clay, loess, weak soil, static load, dynamic load.

I.INTRODUCTION

The large territories of the Republics of Central Asia of Uzbekistan, Kazakhstan, Tajikistan, Turkmenistan and Kyrgyzstan are in difficult ground conditions, i.e. more than 50% of the territory of Central Asia is composed of weak clay, macroporous, subsiding loess, bulk, water-saturated and swelling soils.

The use of the latest achievements of science and practice to improve the quality, reduce the time and reduce the cost of zero-cycle work will increase the reliability of buildings under construction in difficult ground conditions.

During the construction of new buildings and the renovation of existing ones, it is often necessary to transfer considerable loads to the grounds. Under difficult ground conditions, these loads (static, repeatedly applied, dynamic) cause large and often uneven precipitation of building foundations. And although in these conditions hundreds of thousands of structures have been built and are being successfully operated, accidents are also known [1, p.3].

In Uzbekistan, the problem of building industrial civil and agricultural buildings in difficult ground conditions is highly relevant, since many territories of the republic are composed of weak clay, about hillock loess soils. Also, large areas of Uzbekistan belong to seismic areas, where earthquakes of intensity of 8-9 points or more are possible. Ground conditions in seismic areas also relate to difficult ground conditions.

II. SIGNIFICANCE OF THE SYSTEM

It is known that during the construction on weak water-saturated clay and on subsiding loess, as well as in other difficult ground conditions, the precipitation and subsidence of the foundations of buildings turn out to be much larger than is allowed for this type of structure.

Design and erection of buildings on weak clay, subsidence loess soils in areas prone to frequent seismic effects with ensuring trouble-free operation is one of the difficult problems of modern earthquake-resistant construction. The difficulty of this problem is due to the specific properties of wetted weak clay and subsidence loess, one of the most seismically unstable soils that can give a drawdown, measured by several tens of centimeters, and sometimes meters from both additional moisture and vibration. An additional drawdown in case of an earthquake can have a significant magnitude greater than 2-3 times the usual drawdown (according to the data of Professor H.Z. Rasulova, S.Sayfiddinova). This circumstance, along with other factors, leads to catastrophic phenomena associated with the death of a large number of people during earthquakes.

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 subsiding loess soils in seismic zones, as well as an analysis of the effects of earthquakes.

The method of construction of buildings and structures on weak clay and subsiding loess soils was devoted to the works of prof. M.Yu.Abeleva, H.Z.Rasulov, V.A. Il'icheva, S. B.Ukhova, E.A. Sorochan and others.

Numerous analyzes of the cause of the deformation of buildings and structures located on weak clay and interbed loess soils showed that they are characterized by three main features that must be considered when designing buildings and structures:

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-high compressibility of soils, leading to very large precipitation of buildings and structures located on them, and as a result of deformation and accidents of structures;
- their low strength, low values of shear resistance, and the difficulty to ensure the stability of foundations and entire buildings and structures on the soils under consideration;
-long duration of sediment knowledge and structures, sometimes reaching several decades.
In difficult ground conditions, it is necessary when conducting research of foundations composed of loose loess soils, weak clay soils, bulk soils, to take into account that after a while all the soils of the foundation will become water-saturated. When designing buildings and structures, it is necessary to calculate the foundations in difficult ground conditions of the natural moisture of soils and for fully water-saturated soils.

Lack of, as well as low quality of lower-geological surveys are often the causes of erroneous design decisions on the foundations and designs of foundations. Under difficult ground conditions, when designing foundations and foundations, it requires highly and specialized qualifications of designers.
It is often required to predict the behavior of the foundations with a score of more than 9 and estimate possible precipitation. In zones with seismicity greater than 9 points, a more detailed study of the properties of soils with intensive dynamic effects is necessary.

At present, 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 seismic-resistant construction, builders face new challenges, especially in connection with the need to erect structures in areas previously considered unsuitable for construction.

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, subsidence loess, swelling and highly saline soils, as well as high-seismic areas), after a change in the geological environment stationary observations are conducted. At the same time, observations are made by deformations (seismic subsidence, subsidence, precipitation, swelling, displacements, etc.), the groundwater regime (rising groundwater levels, changes in the chemical composition of the soil, etc.), the movement of slopes, etc.

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

The main focus of modern foundation engineering in difficult ground conditions is to refine the survey methods and the design of foundations and to develop new technological methods for constructing artificial foundations and building cost-effective foundations.

During the construction of buildings and structures in difficult ground conditions, in most cases, it is necessary to arrange an artificial foundation and modify the structure of buildings to increase their rigidity, and in order to ensure trouble-free operation of such buildings and structures for a long time, even with the possibility of uneven sludge, special constructive activities; cutting structures by sedimentary seams, the device of monolithic foundations of cross reinforced concrete tapes, the device of interfloor reinforced concrete strapping belts, etc.

It is known that the main constructive event in the construction of civil and agricultural buildings is the use of reinforced concrete and metal belts. As can be seen, some overconsumption of metal occurs here, but operating costs are significantly reduced. It is known that the rigidity of buildings increases significantly when reinforced concrete belts are installed, which are stacked continuously at the level of floors, and when a significant increase in the rigidity of a building is not required, it is possible that reinforced concrete belts are placed at the level of the basement floor and at the floor of the second floor. Industrial and civil buildings built of brick with reinforced concrete belts allow precipitation of 3-5 times larger than panel or block buildings.

Under difficult ground conditions, in the design and construction of multi-storey industrial, civil and agricultural buildings that have a large length, sedimentary seams should be arranged, which should separate the different-floor parts of the building from each other and divide the buildings into rigid blocks of small size. Sedimentary seams are suitable for buildings of great length Taking into account the geotechnical structure of the site, as well as in places where the thickness of the layer of weak clay and loess subsiding changes, in the places of substitution of one type of soil for another with different deformative indicators.

Designing deep foundations or using pile-up racks is most effective with measures that reduce the capacity of weak clay and loess subsiding foundations of buildings and structures.
When building industrial, civil and agricultural buildings and structures on weak clay and loess subsiding soils, deep foundations are used in building practice very often, and they are suitable for any buildings and structures:

It is well known that the installation of deep foundations is practically not associated with particular difficulties and does not require large material costs, and it also becomes possible to build basements without a significant increase in the cost of construction as a whole. With a significant deepening of the foundation, the overall degree of its stability increases, since more favorable conditions are

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created for perceiving the load from the building. In this case, it is possible to use as a preload a more significant thickness of the seals in the boundary with the construction of the side zones.
Sometimes at the base of buildings so weak clay and subsiding loess soils are deposited that the necessary degree of stability of the building cannot be
provided by a number of ways, in particular, the penetration of the foundation. Then, transfer
loads from the structure to stronger, deeper-lying layers, cutting through weak soils, in many cases are solved in the simplest way using pile-posts.

The use of deep foundations and pile foundations can reduce the thickness of weak soils and reduce the design score of the area of construction of the designed buildings.

As noted earlier, groundwater conditions in seismic areas also relate to difficult ground conditions. Professor H.Z.Rasulov proposed method of "earthquake-resistant base" allows quantifying the increments of the construction site balances in each case, taking into account the strength of the underlying soil, the weight of buildings, as well as the intensity and nature of the expected earthquake. The advantage of the “earthquake-proof base” method is simplicity and comparative accuracy. When calculating it does not require any additional costs. Work on determining the parameters of the resistance to shear can be carried out by engineering-geological expeditions and construction organizations engaged in the design of buildings and structures. The use of the “sysmustable base” method allows the designer not only to determine the points of the construction site, but also to take them into account in quantitative terms using the calculated value of the seismicity coefficient.

Designing and erecting buildings and structures on weak clay and subsiding loess soils in seismic areas, ensuring their strength, stability and reliable operation, is one of the difficult problems of modern construction.
Studying the causes of deformations of buildings and structures erected on weak clay and wet subsidence of loess soils under seismic effects shows that uneven subsidence of the foundation and deformation of the erected structures occur with minimal pressure on the soil, and the nature of the deformation of the structure depends on soil conditions and seismic intensity. A typical example of this is the consequences of the Galician earthquakes of 1976, 1984. when not only 2-storey panel and brick houses were completely destroyed, but also lighter, including wooden structures, i.e. Damage occurred to buildings and structures, regardless of the specific pressure transmitted to the substrate and the power of the active (compressible) zone.

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

In this regard, it is necessary to develop a new design principle, based on the conditions of joint work of the entire structure as a whole with the base, i.e. taking into account the strength characteristics of the foundation soils, the specifics of the construction of the building.
One of the most reliable methods to ensure the strength and stability of the facilities, the designation of the value of the calculated pressure on the base and the calculation of the limitation on the average precipitation and the resulting difference in the precipitation of individual neighboring foundations would be the condition when $\alpha_{кр} > \alpha_c$ (where) $\alpha_{кр}$, α_c
- according to the magnitude of the critical and seismic accelerations of the oscillations of soil particles) at all points of the base.
Critical acceleration $\alpha_{кр}$ in the concept of X.Z. Rasulov is generally connected by the strength indicators of the soil in the following form [2, p.127]:

$$\alpha_{кр} = \frac{2\pi g(\text{G}\partial ин.\,tg\varphi w + Cw)}{\gamma w T n V c g \sin 2\pi\, Ƶ/ћв}$$

where g- is the acceleration of gravity;
φw - Angle of internal friction of the soil at humidity W;
Cw - coupling (connectivity) of the soil corresponding to humidity W;
γw - density of wet soil;
T- period oscillation;
Vсд - transverse seismic wave velocity;
Ƶ - depth of the considered horizon:
ћв – wavelength.

In accordance with the formula, the value of critical acceleration in real conditions can be increased by increasing the strength characteristics φ and c.

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The maximum seismic acceleration α_c, corresponding to the point intensity of the seismic zoning map of the territory, is determined by the formula [2, p.28]:

$$\alpha_{сейс} = 4\pi^2 ꭍ^2 A$$

where A-oscillation amplitude; ꭍ-oscillation frequency.

It is known that each type of soil, depending on its composition, state and properties, has its own critical acceleration of the oscillations of soil particles. Critical acceleration $\alpha_{кр}$ most authors such an acceleration of soil particle oscillations, upon reaching which the soil is in a state of maximum equilibrium and a slight excess of acceleration against the critical one, so that the water-saturated soil goes into a state of loss of its dynamic stability, i.e. in a state of "liquefaction". As a result of liquefaction, a decrease in the structural strength of the soil and the development of significant plastic deformations occur both in the soils lying in the zones bordering the foundation and in the sub-foundation zone of the base, leading to unacceptable deformations of the structure itself.

Conditions when $\alpha_{кр}>\alpha_c$ can be achieved by increasing the strength characteristics of soils. One of the ways to increase the strength characteristics of soils is their compaction.

At present, compaction is carried out by one of the known methods: with the help of rollers, heavy tampers, vibration compaction, etc. Based on the conditions of the problem, vibration compaction with rollers is of the greatest interest to our research. Vibration compaction rollers are widely used in the practice of hydraulic engineering and road construction.

In our view, and as evidenced by the research conducted by the researchers, the increase in the seismic resistance of wetted loess soils when using vibration compaction is due to the following factors:

- the soil experiences dynamic effects even before the erection of the structure;
- an increase in density is achieved, which leads to an increase in the values of the friction angle φ and connectivity Cw;
- The value of the critical acceleration $\alpha_{кр}$ increases.

The method of vibro compaction with rollers is the most economical and effective, especially for compacting bulk soils lying around the foundation. This ensures the creation of the corresponding strength of weak clay and subsiding loess soils and in the lateral zones of the basement and contributes to the elimination of seismic subsidence phenomena, respectively, indicating the value of $\alpha_{кр}$ in the considered zones. The massive use of this method in construction practice on loess soils in seismic areas, however, requires additional laboratory and field experimental studies, and its theoretical justification for solving the problem.

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