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FORMATION AND DEVELOPMENT OF SEISMOPROSADOCHNOY DEFORMATION AND UVLAJNYONNYKH LYOSSOVYKH OSNOVANIYAX ZDANI I SOORUJENI

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Abstrakt. The article presents the results of field and experimental studies of some scientists and specialists of the world involved in the study of the behavior of clay and loess soils under natural (seismic) conditions. Information is given on seismic subsidence deformation, the main internal and external manifestations that affect the development and formation of this type of deformation. Improving the strength characteristics of absorbing loess soils for the development of seismic subsidence deformation.

Keywords: weak clay soil; subsiding loess soil; bulk soil; seismic areas; earthquakes; settlement and subsidence; vibration; seismic subsidence deformation; amplitude and frequency; liquefaction; water-saturated; strength characteristics of soils.

Introduction. It is known that in recent years, in connection with the development of mass irrigation of lands in many countries of the world, the level of groundwater occurrence has sharply increased, which has led to a significant moistening of the foundations of buildings and structures. In addition, the territories of some countries of the world are in an area of increased seismic activity (worldwide known earthquakes with an intensity of 9-10 points on the International Scale MSK-64: in 1902 Andijan-Uzbekistan, in 1906 San Francisco-USA, in 1911 New Madrid-USA, in 1911 Alma-Ata-Kazakhstan, in 1923 Japanese, in 1936 Indian, in 1948 Ashgabat-Turkmenistan, in 1949 Khait-Tajikistan, in 1960 Chilean, in 1984 Gazli -Uzbekistan, in 2023 Turkish, etc.). These conditions necessitate the use of such construction methods that would ensure high reliability and durability of buildings and structures.

The design and erection of buildings and structures on weak clay soils, which include moist loess soils, in seismic regions, ensuring their strength, stability and reliable operation, is one of the complex problems of modern construction.

During the construction of buildings and structures on such moist subsidence loess soils in seismic regions, serious difficulties arise due to insufficient knowledge of the nature of the phenomena occurring in such soils during their fluctuations of various intensities.

It is known that loess soils under natural conditions, being in a moist state, are characterized by relatively low strength, which indicates a slight stability of their structure under dynamic influences.

Buildings and structures erected on moist loess soils, even with low-intensity seismic impacts, experience significant seismic precipitation due to structural disturbance and additional compaction of foundation soils.

Taking into account the above phenomena leads to the solution of a set of issues related to the identification of processes that cause dynamic structural disturbance and subsequent compaction of moist loess soils. As is known, due to the lack of studies of the dynamic stability of moist loess soils, as well as the developed calculation methods, designers are not able to correctly take into account soil conditions when designing buildings and structures. Because of this, it often leads to unreasonable solutions to the problems of designing the foundations of buildings and structures and to unjustified economic costs, and in some cases to serious consequences during strong earthquakes.

The study of the causes of deformations of buildings and structures erected on moist subsiding loess soils under seismic impact shows that uneven subsidence of the foundation and deformation of the erected structures occur even at a minimum pressure on the soil, and the nature of the deformation of the structure depends on the conditional soil conditions and seismic intensity. A typical example of this can be serve as the consequences of the Gazli (Uzbekistan) earthquakes of 1976, 1984. and Alma-Ata (Kazakhstan) earthquakes of 1887.1911. when not only 2-story panel and brick houses were completely destroyed, but also lighter ones, including wooden structures, i.e. buildings and structures were damaged regardless of the specific pressure transmitted to the base and the power of the active (compressible) zone.

Taking into account the above data, it can be said that when performing construction work in seismically active areas, soil conditions significantly affect the seismic stability of buildings and structures erected on them, and the need to take into account soil conditions when designing buildings and structures in seismic areas is currently put forward by the construction practice itself.

It should be noted that earthquake-induced disturbances in the stability of earthen dams, dam slopes, river bank slopes and canal slopes, destruction of various types of underground structures, compaction of soil backfill behind retaining walls, subsidence of areas, intense precipitation of massive structures and foundations in conditions of water saturation testify to the mandatory accounting not only inertial forces, but also changes in the working conditions of soils under seismic impact. For the design of buildings and structures, a more detailed description and indicators of the seismic regime of structures and associated soils are required.

This applies to structures erected on moist loess soils, since even with insignificant seismic impacts, natural loess, being in a water-saturated state, as will be shown, have negligible dynamic stability. The mass distribution of loess soils, as a rule, in seismic areas makes the problem of their stability the most urgent.

The analysis of literary sources shows that many issues of seismic stability of moist loess soils, which are encountered in the design of buildings and structures in seismic conditions, have not been resolved, and in the studies conducted, the issues of liquefaction of weak water-saturated clay soils, in particular, loess soils, have not been considered. properties and nature different from sand. Particularly unfavorable in this respect are the most common moist loess soils in seismic regions, which often serve as the foundation of buildings and structures. It is known that, in contrast to the usual subsidence phenomena that occur after a certain period of time as a result of additional moisture, the violation of the stability and deformation of loess soils during shaking usually proceeded quickly and depended on the duration of earthquakes.

Literature Review. From the review of literature data, it follows that the question in terms of our task in a generalized form is absent. However, the studies of the behavior of loess soils under dynamic conditions are the subject of the work of many Russian and foreign scientists.

Research by N.N. Kriger (Russia) showed that seismic subsidence depends on the magnitude of seismic energy, the amplitude-frequency spectrum of vibrations, resonance phenomena, the strength of structural bonds in the rock, etc.

According to A.A. Musaelyan (Tajikistan), the determining factor in the formation of seismic subsidence is the decrease in the strength characteristics of clay soils.

Kh.Z. Rasulov, S.S. Saifiddinov (Uzbekistan) attach great importance to the cohesion of the soil in the loss of strength and the formation of seismic subsidence of loess soil. Seismic subsidence in moist subsiding loess soils during an earthquake can have a significant value, exceeding the usual subsidence by 2-3 times. This circumstance, along with other factors, leads to catastrophic phenomena associated with the death of a large number of people during earthquakes.

S.M Kasymov et al. (Uzbekistan) studied and refined the main factors influencing the change in seismic intensity depending on the set of conditions.

R.A. Niyazov, A.M. Khudoibergenov, M.Sh. Shermatov (Uzbekistan), studying the effect of seismic forces on the resistance of clay soils to shear, came to the conclusion that under the influence of seismic forces, the adhesion and the angle of internal friction of water-saturated clay rocks sharply decrease, and this process is directly dependent on the magnitude of the acceleration, the frequency and amplitude of oscillations, as well as the state of the soil itself.

The results of experiments by A.S. Alyoshin, S.N. Lavrusevich et al. (Tajikistan) showed that an increase in humidity entails a decrease in the strength of structural bonds and a predisposition of loess rocks to seismic subsidence-compaction during earthquakes, explosions, industrial dynamic loads.

As a result of laboratory studies A.I. Lagoisky found that the following main factors influence the loss of soil strength under dynamic influences: the amplitude of vibrations, the mineralogical composition of soil particles, the content of particles in the soil with a size of less than 0.001 mm, soil moisture.

A.A. Mustafayev, I.Sh. Hajizade (Azerbaijan) studied the mechanical characteristics of subsiding loess soils of Azerbaijan under the conditions of a triaxial stress state under the action of cyclic loads with an exposure duration of 2-15 seconds. The studied soils had an initial moisture content of 7.1% and a porosity of 46%. The experiments were carried out at two constant pressures of 0.1 and 0.2 MPa. Based on the results of the research, it was found that at constant vertical pressures, with a decrease in the frequency of the dynamic impact of a given amplitude, the relative deformation increases, at the same time, the strength characteristics of the soil decrease. Hence it follows that by reducing the frequency of dynamic action, the destruction of soil samples is achieved by lower values of sealing pressures.

N.A. Preobrazhenskaya, I.A. Savchenko (Russia) note the influence of vibration frequency on the decrease in soil strength.

A.A. Kagan, Yu.G. Trofimenkov, A.A. Dobrovolsky (Russia) considering the influence of seismic impacts on the strength properties of loess soils, come to the conclusion that the decrease in strength occurs due to adhesion parameters. However, in the studies of other specialists (A.A. Vakhtanova, V.F. Chernyaev, I.P. Bondarev et al., Uzbekistan) it is noted that the angle of internal friction is of great importance in reducing the strength of soils under dynamic influences.

In the 1930s, G.I. Pokrovsky and his collaborators (Russia) for the first time carried out experimental studies of the influence of vibrations on the coefficient of internal friction of soils. Their studies showed that the coefficient of internal friction of the soil with an increase in vibration energy decreases by 25-30% than before vibration.

L.S. Lapidus and others consider the effect of pulsation loads on the strength properties of cohesive soils. They found that the angle of internal friction for cohesive soils under a pulsating load practically decreases to zero.

Studies conducted by M.Yu. Abelev and Kh.G. Gafurov (Russia) on water-saturated loess soils in stabilometers showed that under dynamic loads, the values of the angle of internal friction were 3-6 degrees lower than in static tests, and the adhesion values at this, decreased by 10-17%.

B.P. Kurbanov and E.D. Rozhdestvensky (Uzbekistan), studying the liquefaction of water-saturated loess soils in laboratory conditions, established an increase in the ability of such soils to go into a liquefied state with an increase in their porosity and intensity of dynamic impact. Liquefaction refers to the transition of soil into a liquid or semi-liquid state due to the suspension of particles by excess pressure in groundwater, which occurs in the process of compaction of broken particle structures under conditions of strong shaking.

G. Freindlikh, A.I. Augustinik, B.M. Gumensky, N.A. Gersevanov, P.A. Rebinder and others who studied the phenomenon of thixotropy (thixotropy of soils means their liquefaction during shaking caused by one or another mechanical effect - shaking, stirring, etc.) of clay soils, noted the possibility of the transition of clay soils to a liquefied state due to physical and chemical changes, occurring within the rock during shaking.

V.M. Goldstein and A.V. Ermolinsky (Russia), studying the influence of dynamic impact on the strength characteristics of soils, established: a) in clay soils under dynamic load, the angle of internal friction changes little (by 1-3 degrees), however, the adhesion decreases 2-3 times; b) an increase in frequency with the same value of dynamic and static impact reduces the time to failure without affecting the strength characteristics.

S.R. Meschyan with his students (Armenia-Russia), having carried out experiments to determine the vibration resistance of clay soils to shear at different values of the oscillation amplitude (2A = 0.01-0.2 mm) and a constant frequency (30 Hz), came to the conclusion: a) a decrease in the resistance of the soil to shear occurs as the amplitude of oscillations increases within 2a = 0.1 mm, and a further increase in the amplitude of oscillations has relatively little effect on the resistance of the soil to shear; b) with an increase in the sealing load, the effect of vibration decreases; c) a decrease in soil resistance to shear occurs mainly due to a decrease in the amount of adhesion; d) the angle of internal friction changes slightly (in the direction of increase).

As the result of the data analysis carried out by the author shows, there are different opinions in the appearance of the dynamic structure of disturbed soil and the detection of seismic subsidence (on the development of the phenomena of this phenomenon and the analysis of the manifestations of various manifestations of the literary process of seismic subsidence), i.e. The problem of dynamic stability of water-saturated loess soils, despite the relevance, is still insufficient to study, and according to the results of recent studies, due to the complexity of growth in cohesive soils during their shaking, it is not possible to draw sufficiently reliable conclusions and recommendations that would be used in design.

As is known, with a decrease in the strength of soils at the base of buildings and structures, there is a danger of additional unforeseen and uneven settlement. The importance of the influence of seismic soil settlement on the destruction of buildings and structures during earthquakes was noted by many experts who spoke at world, European, Asian and other meetings and conferences (Karaganda, 1985; Almaata, 1979; Tokyo, 1977; India, 1973; Istanbul, 1973; Sant Yago, 1969; Mexico City, 1969; Japan, 1969; San Francisco, 1956, etc.). For example, in his report, the Japanese scientists I.K. Minami noted that the settlement of the foundations was one of the reasons that caused significant damage to structures during the earthquake in Nom Kok. Japanese scientists Osaka, Kanai, Otsuki, Hausner (Mexico City, 1969) also pointed out the possibility of significant precipitation during an earthquake not only on water-saturated sandy soils, but also on other soils that do not completely turn into a liquefied state during vibration.

N. Ambraseis notes that during the earthquake in Greece in 1965-1966, the formed soil sediments played a significant role in increasing the degree of damage to structures. Such phenomena also occurred in Turkey in 1966 and 1967, according to N. Ambraseis many buildings that experienced uneven rainfall were built on shallow foundations. During the earthquake in Mexico City in 1964, buildings of 12 floors or more leaned a significant amount, although their foundations were based on hanging reinforced concrete ties 16-22 m long. The displacement of one 22-story building reached 1.0 m.

Also, numerous destruction of buildings and structures, due to significant subsidence of the foundations, observed during earthquakes in the USA, India, Japan and Mexico, was noted in the report of E. Bazant.

All of the above clearly indicate the need to develop issues related to the formation of sediment during an earthquake. These questions are, of course, related to the problems of dynamic damage to the strength of soils and the formation of plastic deformations, which are considered in this work.

Conclusions. In conclusion, it should be noted that in the codes of foreign countries for seismic construction there are no requirements for calculating the first limit state, and in Japanese practice, in order to reduce the settlement of foundations in seismic conditions, the allowable pressure on the soil is reduced. This is justified, since the settlement under dynamic impact significantly depends not only on the parameters of the dynamic disturbance, but also on static loads.

The calculated pressure on the base, adopted in Japanese standards, is lower than in the CIS countries (Commonwealth of Independent States, 15 former Soviet republics of the USSR): for example, for sands from 0.05 to 0.30 MPa, and for clay soils from 0.02 up to 0.20 MPa.

The importance of studying the phenomenon of seismic subsidence deformation is dictated by the need to assess and prevent possible damage to buildings erected on weak clayey and subsidence loess soils in seismic zones, as well as to analyze the consequences of earthquakes. It should be noted that in difficult soil conditions and in seismic areas, it is necessary to take into account when conducting studies of foundations composed of subsidence loess soils, weak clay soils, bulk soils, that after some time all foundation soils will become saturated with water, because of this, when designing buildings and structures, it is necessary to carry out calculations of foundations in difficult soil conditions of natural soil moisture and for completely water-saturated soils.

As we noted above, in recent years, specialists have paid great attention to the study of seismic subsidence deformation of loess soils under dynamic influences, however, there are different opinions on this issue, in particular, regarding the causes of this phenomenon and the influence of various factors on the course of the seismic subsidence process.

On the issue of combating the seismic subsidence of loess soils, despite its relevance, there are still no specific data, with the exception of some individual works related to the initial stage of research.

An analysis of the state of the issue shows that despite a certain number of works devoted to studying the effect of dynamic loads on the structural strength of loess soils, the results of the studies still do not make it possible to make sufficiently reliable generalizations and offer quantitative and qualitative recommendations on this issue that could be used in the design grounds.

The issues of structural strength of loess soils under dynamic impacts are insufficiently covered in published works. It is also insufficient to study the development of plastic and subsidence deformations of loess soils under seismic impacts, the development of methods that contribute to the elimination of seismic subsidence deformations and reduce the development of plastic deformations in the subfoundation zone. Considering this, further research patterns of changes in the structural strength of loess soils under dynamic influences, depending on various internal and external factors, in order to combat the development of plastic zones under the base of the foundation, is certainly of considerable scientific and practical interest.

Hence the need to develop issues related to the formation of deformation during an earthquake and related to the problems of dynamic strength failure (liquefaction) and compaction of moist loess soils. At the same time, due to the exceptional importance of the problem and the impossibility of a practical solution to the problems of assessing the stability of buildings and structures erected on moist loess soils in seismic regions, it is inevitable to study the conditions for violations of the structure of water-saturated loess soils when exposed to dynamic loads of varying intensity and nature with the identification of factors that affect the process.

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