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The device of the bases and foundation in the conditions of weak soil and high seismic activity of the Republic of Tajikistan

L'appareil des bases et de la fondation dans les conditions de faible sol et la haute activité sismique de la République du Tadjikistan

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ABSTRACT: The results of years of research characteristics flooding and water logging areas in the Republic of Tajikistan, previously folded little moisture loess soils subsidence. Found that the water saturation of the soil contributes to the transition into the category of weak and high compressibility, a significant reduction in their strength and deformation parameters. The studies will improve the effectiveness of design and construction of buildings and structures in seismically active areas.

RÉSUMÉ : Les résultats d'années d'inondation de caractéristiques de recherche et de régions de notant d'eau dans la république du Tadjikistan, a plié auparavant peu d'affaissement de sols de lœss d'humidité. Constaté que la saturation d'eau du sol contribue à la transition dans la catégorie de faible et haute compressibilité, une réduction significative de leur force et paramètres de déformation. Les études amélioreront l'efficacité de design et la construction de bâtiments et de structures dans les régions sismiquement actives.

KEYWORDS: weak water-satureted loess soils, the high-condensed soil pillows, deformations at static and seismic loadings.

1 INTRODUCTION

In many seismically active regions of the Republic of Tajikistan weak water-saturated soil on which industrial and civil constructions of different function are erected and operated are widespread. Researches and operating experience of constructions on this soil testifies to considerable decrease in strength and deformation characteristics of soil at seismic influences and indicates the need of their account at calculation of the bases. Various methods of artificial improvement of properties of soil and the pile foundations are applied to decrease in influence of seismic influences and increase of seismic stability of constructions.

For a number of years in the country complex laboratory and field (natural) researches of features of work of the uniform and artificial bases, and also stuffed piles were carried out at seismic influences. In field conditions imitation of seismic forces is made by means of the explosive influences which essence is that by means of explosion separately set parameters of seismic forces for the purpose of the solution of specific objectives receive (Medvedev S. V. 1967, Lekarkin V. K. 2005, Usmanov R.A. 2009).

Thus explosive influence only on separate dynamic characteristics can come nearer to certain types of earthquakes. The specified method widely is used at the solution of geotechnical tasks in difficult engineering-geological conditions of the republic.

2 THE HOMOGENEOUS BASES

The purpose of researches was studying of influence of seismic (explosive) impacts on decrease in bearing ability and increase in compressibility of the uniform bases put by weak water-saturated soil. Field researches were conducted on the experimental site put by weak water-saturated loess soil more than 16,0 m thick, a way of a simultaneous loading of two round metal rigid stamps by the area A = 1,0 sq. m (d = 1,13 m) static and seismic (explosive) influences (fig. 1). By results of static tests of value of calculation resistance of soil made R ≤ 100 kPa, and the deformation module - E = 2,7-3,5 MPa (fig. 2). The analysis of development of layer-by-layer movements of soil on depth of the basis shows that more than 90% of the general deformations occur within depth equal to diameter of a stamp.

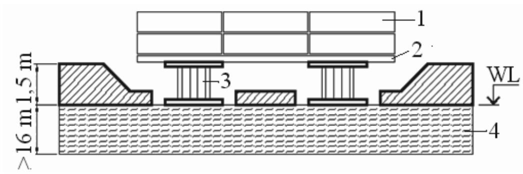

Figure 1. Scheme of carrying out static tests:
1- load pulleys; 2- metal platform; 3- metal stamp; 4- weak soil

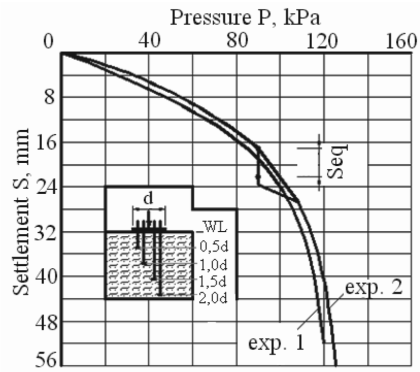

Figure 2. The results of static tests by stamps

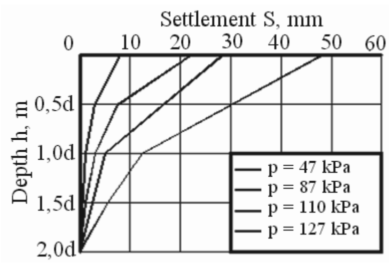

Figure 3. Development of deformations on basis depth

When carrying out static tests No. 2 there was a natural earthquake intensity of 7 points and lasting about 2 minutes at which average pressure on a sole of stamps made p = 87 kPa ≈ 0,9R, i.e. 90% from the size of calculation resistance (bearing ability) the bases. The measured sizes of additional increments of deformations of stamps and deep brands made 27% from the total value, recorded at static tests (Usmanov R.A. 2009).. In this case, as well as at static tests, increments of additional deformations of soil also were recorded at a depth equal to diameter of a stamp and more than 80% of their size occurred at a depth to an equal half of diameter of a stamp.

0,4 m that is connected with increase of steam pressure in the thickness of soil when passing seismic waves.

As a whole, results of numerous pilot studies and operating experience of various constructions in the conditions of weak water-saturated loess soil show that seismic influences by intensity of 7, 8 and 9 points promote decrease in bearing ability of soil of the basis of stamps and the foundations for 10, 20 and 30% respectively.

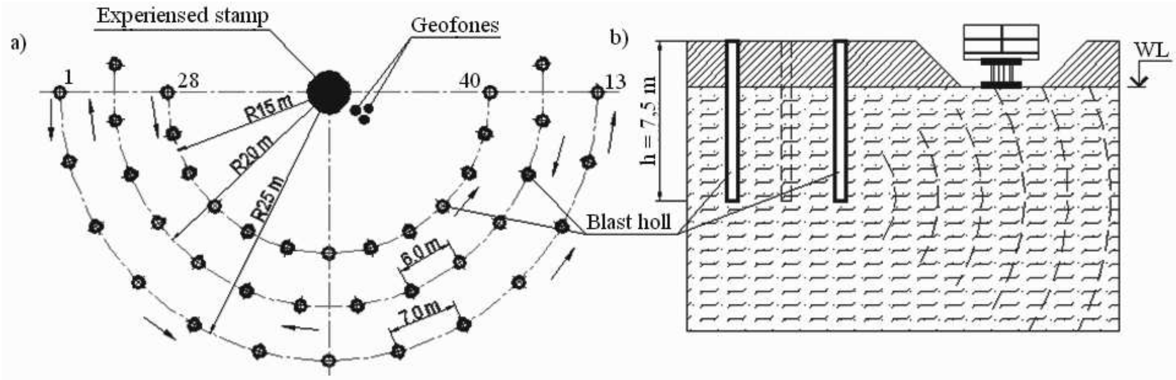

Figure 4. Scheme of carrying out tests by explosive influences:
a) the scheme of an arrangement of skilled stamps and explosive wells
(1 - 40 numbers and an order of detonation of wells); b) section of an experimental site

Before tests of weak water-saturated soil for explosive influences, by analogy to static tests, load of stamps was finished to 80 kPa (0,8R), i.e. made 80% from bearing ability of the basis. Imitation of seismic influence it was carried out by means of camouflage explosions of charges of the explosives located at a certain distance and depth from a tested site (fig. 2a, b). as the settlement parameter of intensity of explosive influence the speed of fluctuation of the soil, well correlating with a mass of a charge and epicenter distance was accepted. For installation of charges of explosive in thickness of weak soil the special explosive columns, consisting of the metal container for installation of a charge of explosive by diameter of d = 0,22 m and height h = 1,0…1,2 m, and also the upsetting metal pipe welded on it d = 0,05 m (fig. 3) which immersion on necessary depth was made by means of the drilling rig.

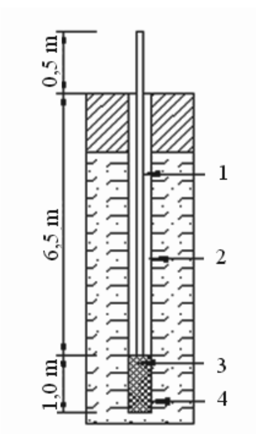

Figure 5. Scheme of an explosive column:
1 – pipe d = 0,05 m; 2 – borehole d = 0,22 m;
3- charge of explosive; 4- pipe d = 0,2 m

At explosive impacts of deformation of stamps continuously increased and there was a loss of their stability. In the course of tests of underground water rose above a sole of stamps by 0,3 -

13 THE CONDENSED SOIL PILLOWS

In the conditions of the republic one of most widely applied artificial methods of preparation of the bases is the device of the condensed sandy and gravel pillows that is explained by existence of a large number of a natural standard material, its low cost and efficiency of their application in practice of construction. The corresponding researches and experience of design specify that 1,0 diameters of a stamp or base width are recommended to appoint thickness of the condensed soil pillows not less than 0,75d. In this direction the great interest is represented by researches of features of the device and work of the high-condensed gravel and sandy pillows (at the density of dry soil $\rho_d \geq 2{,}2$ t/m^3 and coefficient of consolidation of k_{com} > 1,0) on weak water-saturated loess soil with consistence I_L = 0,8 (Usmanov R.A. 2009). The specified pillows were arranged on weak soil with thickness h = 0,5; 0,75 and 1,0 m. By results of tests the calculation resistance (bearing ability) all artificial bases made more R = 500 kPa that more than by 5 times exceeds value of calculation resistance of weak soil of natural addition (R = 90 kPa).

Researches of work of the high-condensed pillows at explosive influences by intensity of 9 points were conducted on a site where on a mark of underground water it was arranged high-condensed (ρ_d > 2,2 t/m^3, k_{com} > 1,1) a gravel pillow with thickness h = 0,75 m on water-saturated loams with consistence I_L = 0,8. On a skilled site stamps by the area A = 1,0 sq. m (d = 1,13 m) were established and loaded by a technique of static tests up to the average pressure on a sole p = 480 kPa (fig. 4). For comparison results of test of stamps are given in the same schedule in the conditions of weak soil at the size of average pressure p = 80 kPa (Usmanov R.A. 2009). Imitation of seismic forces was carried out by means of explosive influences, similar to a technique given in fig. 2 and 3.

The maximum gain of deformations of stamps at seismic fluctuations made all S_{eq} = 7% from the general a precipitation recorded at static tests. As a whole, the obtained experimental data and the subsequent experiment of construction showed on high efficiency of application of the high-condensed pillows from sandy and gravel materials in the conditions of weak water-saturated soil and high seismicity of the region.

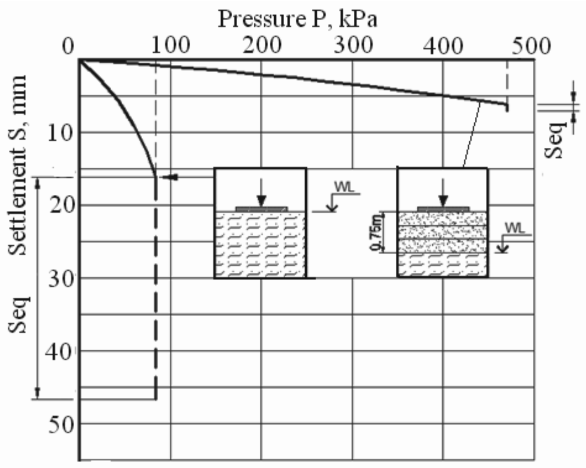

Figure 6. Results of test of the condensed pillows at explosive influence

14 THE BASES CONDENSED BY VERTICAL SANDY DRAINS

In the Republic of Tajikistan territories mastered under construction often can be put by big thickness (more than 15 m) weak water-saturated loess soil of a soft plastic and fluid consistence ($I_L \geq 0,8\ldots1,0$). In these conditions, and sometimes and the unique method, before construction consolidation of thickness by sandy drains is effective. For identification of opportunity and efficiency of application of this method in soil conditions of the republic natural pilot researches were conducted.

The purpose of researches was studying of features of consolidation of weak water-saturated loess soil at the device of vertical sandy drains with the subsequent their loadings the weight of a soil embankment in the conditions of static and seismic influences. Researches were conducted on a platform which on depth more than 16 m was put by water-saturated lessial loams with consistence I_L= 0,80, the calculation resistance of R ≤ 90 kPa and the module of deformation E = 2,0 … 2,7 MPa. On an experimental areas 3 sites by the sizes of 10 x 10 m everyone were prepared. The first site was loaded without the device of vertical sandy drains, on the second site sandy drains on a grid 2 x 2 m, and on the third – on a grid 3 x 3 m, 6,0 m long and with a diameter of 0,4 m were arranged (Usmanov R.A. 2009).. Transfer of static loading was carried out by layer-by-layer dumping of an embankment from a gravel and loamy material.

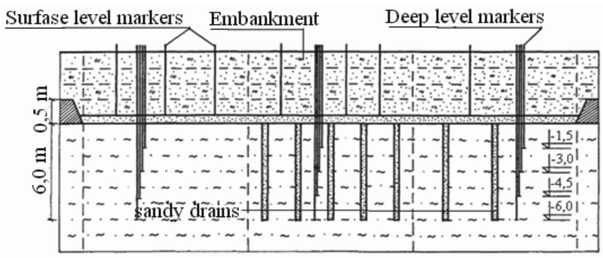

Figure 7. Scheme and results of consolidation of soil by sandy drains
1- surface level markers; 2- deep level markers

It was thus established that the main part of deformations of thickness of soil occurs during the first 5…6 days after the appendix of each step of loading (fig. 5). By results of supervision over development of layer-by-layer movements more than 70% of the general deformations of thickness of weak soil occurred at a depth of 3,0 m, and at a depth of 1,5 m - more than 50%. After completion of works on consolidation of soil by static loadings, complex researches of their strength and deformation properties were conducted. Results of researches showed that despite rather small size of condensing static loading, value of calculation resistance of soil raised to R = 200…250 kPa (by 2,2…2,8 times), the deformation module to 2,4 times, the intercept cohesion in 1,6…2,0 times.

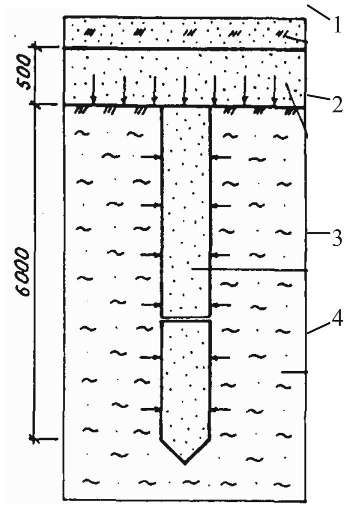

Figure 8. Scheme of a vertical sandy drain
1- embankment; 2- sandy pillow;
3- vertical sandy drain; 4- weak soil

Imitation of seismic influence by intensity of 8-9 points on the condensed massif was carried out by means of short delay camouflage explosions of charges of explosive by a technique given in fig. 2 and 3. By results of the made experiments (fig. 5) of an increment of additional deformations of condensed thickness at explosive influences made about 30% from the general a precipitation recorded at static tests that is obviously connected with sharp increase of excessive hydrodynamic pressure in steam water which promotes acceleration and additional its filtration in sandy drains (Usmanov R.A. 2009)..

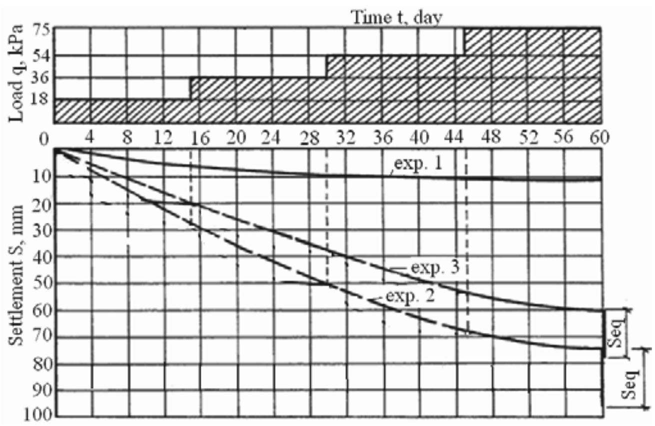

Figure 9. Development of deformations experimental sites in time

5 THE STUFFED PILES

Operating experience of buildings and the constructions erected on the pile bases in various seismic regions shows on reliability of their work in the conditions of weak water-saturated soil. Taking into account it on weak water-saturated loess soil of the republic researches on technology of the device and features of work of ferroconcrete vibro-stuffed trailing piles by diameter of d = 0,4…0,6 m and long L = 6,0…8,0 m were conducted. By results of static tests bearing ability of a stuffed pile diameter of d = 0,6 m and long L = 8,0 m made p = 100 kN.

Taking into account it at test of a similar pile for explosive influences the size of static squeezing loading was accepted equal p = 80 kN, i.e. 80% from the bearing ability received by results of static tests (fig. 6). At explosive influence by intensity of 9 points additional increments a deposit of a skilled pile reached S_{eq} = 13,4 mm that makes about 50% from value a precipitation received at static test (Usmanov R.A. 2009).

The analysis of results of pilot studies point to an inefficiency of application of stuffed trailing piles both at static and at explosive influences. In the conditions of weak water-saturated soil and high seismic activity of platforms of construction of a pile it is necessary to arrange in the form of piles racks with deepening of their bottom end in strong and low-squeezed layers of soil.

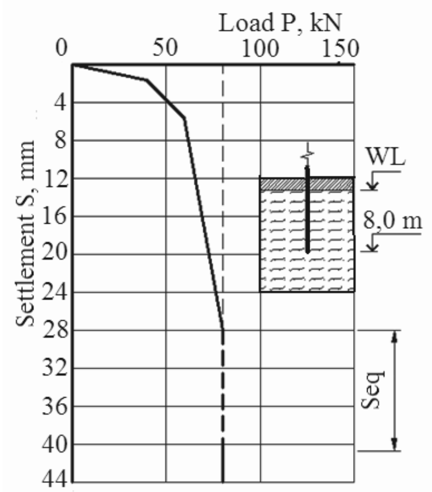

Figure 10. Dependence of deformation of a pile on loading at explosive influence

6 CONCLUSIONS

1. The conducted pilot researches, depending on intensity of seismic influences, established decrease in bearing ability of the bases put by weak water-saturated soil, within 10…30% and development of considerable additional deformations. For the better and quantitative analysis carrying out simultaneous tests of several stamps is expedient at static loadings, components 0,8; 0,7; 0,6 and 0,5 from the size of limit bearing ability of the bases (R);

2. The device of the high-condensed soil pillows from sand and gravel and pebble or sandy materials in the conditions of weak soil and high seismic activity of platforms of construction is one of the most effective methods, allowing considerably to increase bearing ability and to reduce compressibility of the artificial bases, both at static, and at seismic influences. Thus not less than 0,75 width of the foundation are recommended to appoint their thickness;

3. At consolidation of weak water-saturated loess soil by vertical sandy drains and embankment weight dynamic influences lead to increase in additional deformations of thickness of soil and promote consolidation improvement of quality.

4. Seismic (explosive) influences lead to loss of bearing ability of stuffed trailing piles and development considerable additional a deposit that as well as results of static tests, testifies to an inefficiency of the device of trailing piles in the conditions of weak water-saturated loess soil and high seismicity of the region.

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