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INVESTIGATION OF ACCURACY OF DETERMINATION OF SUBSIDENCE FOUNDATIONS OF ENGINEERING STRUCTURES AT THE STAGE OF SOIL CONSOLIDATION

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Problem statement. In modern geodetic literature are examined many questions in relation to accuracy of observations at subsidence and deformations of buildings and structures. However in many cases accuracy of measuring is appointed without the adequate substantiation. For observations, that embrace the different by the nature processes of consolidation, identical accuracy and methodology of measuring are accepted.

The regular observations at subsidence and deformations of engineering building begin after completion basic building and construction works. From it the sizes of subsidence for this period remain unknown practically. Thus, it is impossible correctly to judge about the size of the absolute subsidence of building and potential reasons of violation of normal building's use.

It is considered that the so-called "primary settling" that is conditioned by the soil consolidation in the period of building of construction site reach a maximum [2]. The establishment of necessary accuracy of the geodetic observations at subsidence is the one of basic tasks on this stage.

Analysis of the last researches and publications. Building bases, as known, are one of the basic parts of building that take the load from building and pass to the basis. The subsidence of compression of soil's compressive zone under foundations (long-lived deformation of compression of bases) is the biggest in magnitude and depends on soil characteristics of active zone of compression under foundations. On power of active zone the size and inflexibility of foundations and soil consolidation influence in turn [11]. On the stage of soil consolidation all points of foundation get the identically guiding.

Subsidence prediction of building's foundations on the stage of compression of bases are done with the use of the methods based on the decision of tasks from the theory of consolidation [1,11].

For the calculation of subsidence of raft reinforced-concrete foundations of engineering building a analytical model in the form of flexural deforming half-space with the use of methods of layer by layer addition or equivalent horizon of soil is provided in [10]. The subsidence of equivalent horizon of soil at the distributed load accurately it equals to the foundation's subsidence at the powerful array of soil [11].

The algorithms of determination of subsidence of significant points of flexural rectangular foundation with the use of method of angular points of equivalent horizon of soil are driven in [9].

Method for determination of acceptable subsidence of foundations of gas-compressor unit of compressor stations under the influence of static loading taking into account the acceptable value of deflexion of foundation plate is described in [6].

Precision and informativeness of determination of foundation's subsidence at the stage of soils consolidation depending on the location of deformation marks are considered in [4]. The results of the investigation for the series of models of rectangular foundation also are given.

In the advanced study [5] the method of calculation of acceptable values of deformation parameters of foundations of gas-compressor unit of compressor stations including functional dependences of subsidence from the relative size of foundation and maintenance of optimal three-dimensional position of axes of equipment is described.

The method of calculation of determination accuracy of subsidence of engineering building's foundations based on taking into account of subsidence irregularity of the points placed over at the longitudinal axis of foundation, is considered in paper [3].

In these works it is not spared sufficient deal of interest the maximal subsidence irregularity of the points of flexible foundation at the calculation of accuracy of geodesic observations.

Problem definition. The goal of research is a computation of observation accuracy of subsidence of engineering buildings in the process of soil consolidation depending on the maximal value of the differential subsidence of points of flexible foundations.

Exposition of basic material. One of basic parameters of necessary observation accuracy is a mean-square error of weight unit μ that characterizes technique of measurement.

Connection between mean-square error of weight unit μ and necessary observation accuracy can be expressed by such formula [2]:

$$\mu \le \frac{m_{\Delta S}}{\sqrt{2\pi_{\Delta H}}}, \quad (1)$$

where $m_{\Delta S}$ - mean-square error of measuring of difference of subsidence ΔS; $\pi_{\Delta H}$ - invert weight of elevation between the investigated points.

When observation at the subsidence made by the method of the leveling as an error μ of weight unit, as a rule, accept the mean-square error of measuring h, measured at the station on corresponding methods [2].

After approximate calculations necessary accuracy of leveling procedure can be defined from the maximally acceptable or critical value of the differential subsidence $\Delta S_{\hat{e}\eth}$ for this building. In this case the permissible mean-square error of measuring of difference of subsidence $m_{\Delta S}$ is expected after a formula [2]:

$$m_{\Delta S} = \frac{\Delta S_{\kappa p}}{kt}, \quad (2)$$

where $1/k$ - coefficient of forgetful influence of errors measurement; t - the rated factor in passing from a limiting error to mean-square error.

For the closely-spaced marks of observation in a formula (1) accept $\pi_{\Delta H} = 1$. In this case mean-square error of weight unit will be determined [7]:

$$\mu = \frac{\Delta S_{\kappa p}}{\sqrt{2}\cdot kt}. \quad (3)$$

For especially important building at $k = 3$ (accuracy of account of influence of errors $q_k = 5\%$) and at $t = 3$ (probability value $P = 0.9973$) the formula (3) will be such [7]:

$$\mu = 0.08\Delta S_{\kappa p}. \quad (4)$$

For the determination of subsidence irregularity of foundations at the stage of soil consolidation in the conditions of the evenly distributed load the values of subsidence of points of model rectangular flexible reinforce-concrete foundation with the use of method of angular points of equivalent horizon will be expect [11].

Parameters of model of foundation and soil conditions: length of foundation $l = 17m$; width of foundation $b = 4m$; slab thickness of foundation $P = 0.0295\text{mPa}$; middle reduced factor of the contraction strain of soil $m_V = 3.7\cdot 10^{-4}\, cm^2/H$; coefficient of lateral expansion of soil $\mu_0 = 0.2$.

The values of the eventual (stabilized) subsidence of points of the listed model of foundation are given schematically (Fig.1).

Lines of the even subsidence and three-dimensional image of subsidence of foundation's models built using the software suite *Surfer*, and are presented accordingly on Fig.2 and Fig.3.

As known from [11], maximal subsidence irregularity $\Delta S_{\max}$, arises between the central S_0 and angular S_c points of foundation, in other words

$$\Delta S_{\max} = S_0 - S_c. \quad (5)$$

The value $\Delta S_{\max}$ can be computation at the approximate formula [4]:

$$\Delta S_{\max} = (1.1884/\alpha^{0.0224} - 0.5946/\alpha^{.0229})\cdot S_m, \quad (6)$$

де α - співвідношення сторін прямокутного фундаменту; S_m - прогнозована величина середнього стабілізованого осідання фундаменту (розрахована методом еквівалентного шару грунту).

where α - height-to-width aspect ratio of rectangular foundation; S_m - predicted value of the mean stabilized subsidence of foundation (calculated by the method of equivalent horizon of soil).

In our case (Fig.3) the value $\Delta S_{\max}$=4,66 mm. If instead $\Delta S_{\hat{e}\eth}$ accept the subsidence irregularity, calculated at the formula (6) that for this model of foundation using formulas (2) and (4) accordingly will get:

$m_{\Delta S} = 0.52mm$;

$\mu = 0.37mm$.

Using the got mean-square error of weight unit μ, choose the corresponding methodology of subsidence measuring.

For example, during determination of subsidence by the method of the geometric leveling of first class the mean-square error of weight unit in accordance to [8], makes a 0,32 mm.

If length average of collimating ray is 10 m that mean-square error of weight unit μ_{10} will be 0,14 мм [8].

The accuracy of construction of height control estimated depending on necessary accuracy of subsidence determinations.

Conclusions. The method of calculation of accuracy of subsidence determinations can be used for the geodesic observations at subsidence and deformations of flexible rectangular foundations of engineering building and technological equipment on the stage of soil consolidation.

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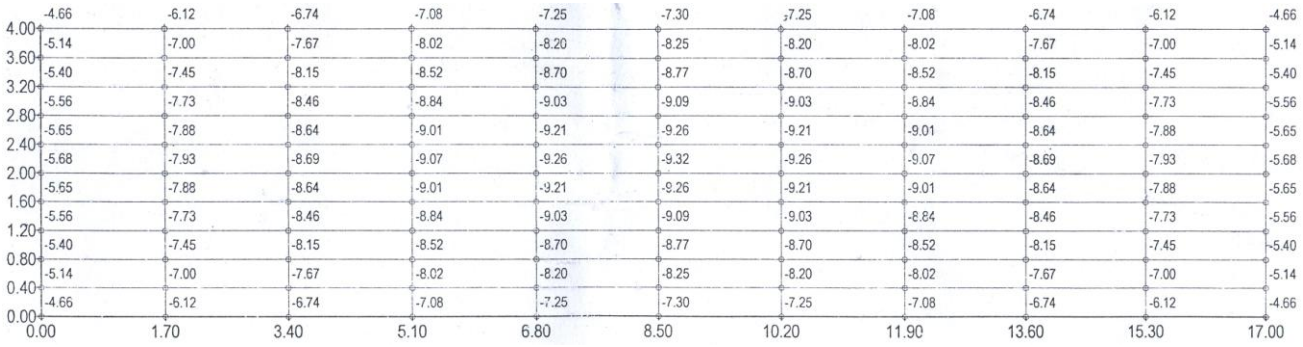

Fig 1. The value of the subsidence of the points of model flexible foundation

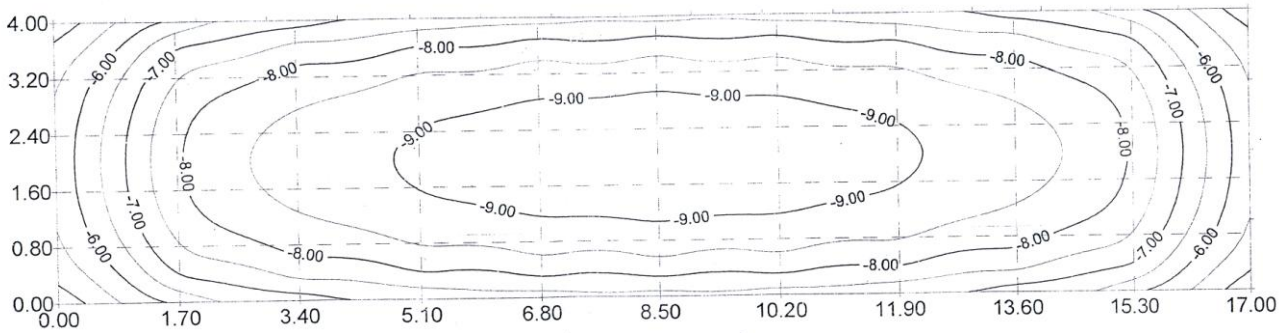

Fig 2. Isolines of subsidence of model of flexible foundation (Vertical interval is 0,5 mm)

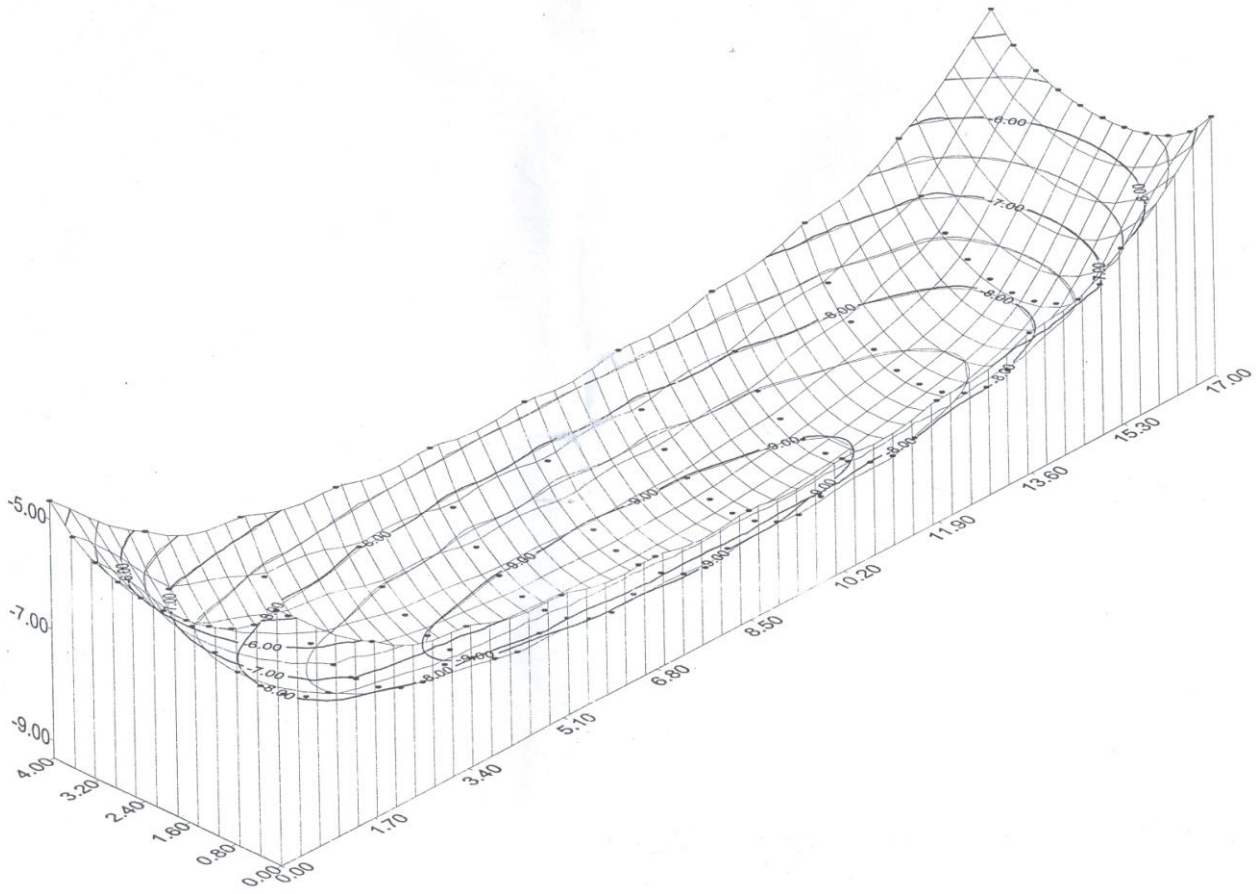

Fig 3 Three-dimensional image of subsidence model of flexible foundation

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Investigation of accuracy of determination of subsidence foundations of engineering structures at the stage of soil consolidation

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In the article the results of calculation of observation accuracy of subsidence and engineering building in the process of soil consolidation depending on the value of the differential subsidence of points of flexible foundations are given.

For establishment of necessary accuracy of measuring of subsidence it was suggested to made them on the basis of modelling of foundations subsidence with the use of method of angular points of equivalent horizon of soil.