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## COMBINATION OF GEODESIC CONTROL METHODS OF MAIN GAS PIPELINES AND UNDERGROUND GAS STORAGES

Geodetic monitoring of main gas pipelines and underground gas storages is based on high-quality, high-precision measurements, which allow to prevent the detection of dangerous manifestations during the operation of strategically important elements of the fuel and energy complex. The gas transportation system of Ukraine ranks second on the European continent in terms of its technical parameters. A widely developed network of gas pipelines is closely connected with artificially created underground gas storage facilities [1]. That is why such objects should be considered as a whole, since their functioning and operation are closely interconnected. They form the basis of the gas transportation system as a whole.

The use of non-destructive testing methods, to which the geodetic method belongs, has a number of advantages [2]. First of all, this is an opportunity not to stop the operation of the gas transportation system, but to carry out geodetic measurements regardless of the technological process of the object (fig. 1).


Fig. 1 – Main gas pipeline networks on the map of Europe

For the organization of geodetic monitoring, special networks are laid in individual sections of the gas transportation system where surveying is required.

It is convenient to use the existing points of the geodetic base or to lay down new ones, relative to which the location of all other characteristic points of the terrain or equipment elements of a strategically important object will be determined. In some cases, it is possible to determine the height, plan or height-plan position of the points, depending on the tasks.

The combination of remote and ground methods of gas transportation system monitoring will improve the process of tracking and detecting changes in the position of characteristic points. World experience demonstrates the high-quality use of satellite images, with their professional processing. Interferometric Radar X-Ray Spectroscopy (InSAR), an active Earth remote sensing technology that acquires images of the Earth, is a powerful technology for modeling surface deformation and elevation mapping on the surface of the globe. The method is used for geophysical monitoring of natural hazards, such as earthquakes, volcanic eruptions, landslides, as well as in structural design, including subsidence and structural stability monitoring [3]. It is worth using experience and monitoring strategically important objects, using the latest technologies.

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## EXPERIMENTAL JUSTIFICATION OF THE NEED TO CONSIDER THE EFFECT OF VERTICAL SAND DRAINS COLMATATION DURING THEIR DEVICE IN WEAK WATER-SATURATED SOILS

One of the assumptions of the existing methods for calculating the compaction of weak clayey water-saturated soils when vertical sandy drains are installed in them is the unlimited filtration capacity of the material from which the drains are made [1, 2].

In fact, this material (sand) initially has a finite value of the filtration coefficient, which significantly exceeds the value of the filtration coefficient of the compacted soil.

However, as the consolidation process proceeds, the soil particles surrounding the drain penetrate into it with the current of pore water squeezed out of it, and the filtration capacity of the drain decreases.

The purpose of our experimental studies was to establish the influence of the filtration coefficient of the drain material on the rate of consolidation of silty water-saturated soil with sandy drains.

At the same time, the effect of drain silting in the process of consolidation was studied by making them from a material with different values of the filtration coefficient. Mixtures of pure quartz sand with a fraction of 0.25–0.50 mm and silt powder with a fraction of 0.10–0.25 mm were used as such material at different ratios of their volumes.

4 series of experiments were carried out on the consolidation of cylindrical samples of silt paste with a diameter of $D$ = 140 mm and a height of $H$ = 50 mm with a central drain with a diameter of $d$ = 20 mm ($n = D/d = 7.0$):

– Series I: experiments with a drain of pure sand;
– Series II: tests with a drain of a mixture of sand and silt in a ratio of 3:1 (by volume);
– Series III: the same, in a ratio of 1:1;
– Series IV: the same, in a ratio of 1:3.

In the experiments of all series, the initial moisture content of the silt paste was equal to twice the yield strength of the original soil – $W_n$=2$W_L$.

The experiments of each series were carried out with 3 repetitions (12 experiments in total) in non-standard devices (odometers) of a special design, which excludes the extrusion of weak clay water-saturated soil from under the stamp and its distortion during the experiment.

The sealing load on the test specimens, equal to 0.1 MPa, was created over a period of 10 minutes by five equal steps of 0.02 MPa each with holding each load step for 2 minutes, which ensured that the soil was not squeezed out from under the stamp.

The results of the performed experiments on the consolidation of samples of silt paste with the radial direction of pore water filtration (into the central drain) were processed according to the methods of Taylor and Casagrande [3] and presented in the form of tables [4]. The values of the consolidation coefficient $C_R$ in the radial direction, by analogy with the determination of the consolidation coefficient $C_V$ in the vertical direction of filtration, were determined by the formula: