Western European Journal of Modern Experiments and Scientific Methods
Volume 2, Issue 6, June, 2024
https://westerneuropeanstudies.com/index.php/1
ISSN (E): 2942-1896 Open Access| Peer Reviewed

MEASUREMENT OF DEFORMATION OF BUILDINGS AND STRUCTURES BY GEODETIC METHODS

Akhmedov Bakhriddin Madaminovich
Uzbekistan, Fergana Polytechnic Institute
b.axmedov@ferpi.uz

Annotation: This article highlights information about the measurement of deformation of buildings and structures by geodetic methods, calculation tasks using a certain type of alignment in the study of precipitation.
Key words and word expressions: geodetic instruments, geodetic instruments, leveling nets, reconnaissance, reference point, grade, leveling, invar rail.

INTRODUCTION

Deformation of structures occurs as a result of the influence of various natural and man-made factors on their foundation and the structure itself. Basically, the deformation of buildings and structures depends on the displacement of the rocks on their foundations. These movements can occur vertically and horizontally.

Vertical deformation of foundations is divided into:

Subsidence-deformations occur as a result of compaction of the soil under the foundation under the influence of external influences and in some cases under the influence of its own weight, and the structure of the soil does not change fundamentally;

Compression deformations, which occur as a result of soil densification and cause a radical change in the soil structure due to external influences, for example, soil wetting, thawing of frozen soil, etc.;

Swelling and shrinking deformations, changes in the volume of the soil as a result of the influence of various chemicals on the clay soil layer or changes in its humidity and temperature;

It occurs as a result of sedimentation deformations, extraction of underground mineral resources, and changes in hydrogeological conditions.

Mathematical characteristics of foundation subsidence are expressed by the magnitudes of vertical sections between the initial and after subsidence planes of the foundation.

If these sections are equal in all corners of the foundation of the structure, such subsidence is called uniform subsidence, if the sections are not equal, it is called uneven subsidence [1-5].

THE MAIN PART

Causes of deformation

As shown above, the deformation of foundations occurs as a result of the influence of natural and man-made factors on it.

Natural factors include:

1) susceptibility of rocks to various engineering-geological and hydrogeological phenomena;

2) freezing of rocks in the cold and melting of frozen rocks;

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ISSN (E): 2942-1896 Open Access| Peer Reviewed

3) changes in hydrometric conditions, long-term changes in temperature, humidity and groundwater level.

Man-made factors include:

1) the effect of the structure's own weight;

2) changing the nature of rocks due to artificial rise and fall of underground water;

3) weakening of the foundation as a result of underground works;

4) change of pressure (force) on the foundation as a result of the construction of an additional floor to the building or the construction of a new building next to it;

5) vibration of the foundation due to the operation of various aggregates, traffic.

At the same time, the deformation of the structure is affected by the shape, dimensions and strength of the foundation [6-10].

Methods of measuring vertical deformation

The position of the marks to be placed to determine the deformation depends on the measurement method adopted.

The following geodetic methods are used to monitor the subsidence of structures and their foundations.

a) geometric leveling with a short visor beam (up to 25 m);

b) short range trigonometric leveling (up to 100 m);

c) hydrostatic leveling in moving equipment or fixed system;

g) obtaining a surface photogrammetric and stereophotogrammetric plan.

The microleveling method with a base of 1-2 meters can also be used to monitor unique structures.

To determine the absolute full value of the subsidence, leveling is carried out according to a fixed reference, which is taken as a starting point. Relative subsidence is obtained from the difference in measurements between certain points of the structure.

The most commonly used method for subsidence monitoring is high-precision geometric leveling. Leveling is carried out along the marks, which are considered as subsidence marks. These marks are installed on the foundation of the structure and they move with the structure, so by observing them we can determine if individual parts of the structure are sinking.

When determining the subsidence of individual brands, the height base is served by fundamental rappers, which are placed at a certain distance from the observed structure, on the edge of the subsidence funnel. The stability of the height states of these rafters should be maintained during subsidence monitoring.

Character placement project

The placement of dive stamps and base geodesic Marks is one of the main works when determining the steep and horizontal displacement of individual points of structures. The quality and detail of determining the displacement will depend on the correct placement of the characters and their number. Therefore, the place of signs should be determined with the participation of a geodesist, specialists of foundations and foundations, geologists and gruppas of the general plan design enterprise. Of all the possible options for placing signs that can fully reflect the displacement, it is necessary to pay attention to the adoption of the most convenient for geodesic work.

The project for placing stitch marks on structures is compiled taking into account the foundation structure, loads at certain places of the base, hydrological and geological conditions. It should be advisable to place the sinking stamps at the same level as possible, at the corner of

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the buildings along the transverse and longitudinal axes of the foundation; the following places where large-value dives are expected: adjacent block seams, sides of dipping and kharorat seams, around zones with large dynamic loads, and around zones that are not favorable from geological bias.

According to the established norms, load-bearing brick with a meticulous wall and a Ribbon Foundation, dipping stamps for living and public buildings are placed at intervals of every 10-15 m along the perimeter of the foundation. In buildings with a width of more than 15 m, stamps are mounted on transverse walls at the intersection of the transverse axis with the longitudinal axis.[11-15]

Dipping stamps for industrial structures and frame living and public buildings are installed on load-bearing columns along the perimeter of the building and its interior. Stamps are placed at least three on longitudinal and transverse axes in each direction.

For living and public buildings without a large panel frame with a prefabricated reinforced concrete foundation, sinking stamps are installed along the perimeter and axes of the building approximately 6-8 meters after each of the two steps of the panel.

In buildings with a pile foundation, dipping stamps are placed on the longitudinal and transverse axes of the structure at least 15 meters.

Moving stamps, plates to place for multi-storey production and industrial structures with a monolithic foundation slab is placed on a single stamp account with longitudinal and transverse axes and an area of 100 m2 on its perimeter.

For Circular masonry, domna furnace, Assembly towers, elevator and other similar structures, no less than four dipping stamps are installed along the circular perimeter.

In separate sectional hydrotechnical facilities, at least three marks are engraved per sectional: at least four marks when the sectional width is greater than 15 m. It is also recommended to install several brands of Yarus (on top of the structure, in galleries) along the perimeter of the upper and lower edges (bays).

Stamps for coastal and protective walls are installed along the perimeter every 15-20 m. In the event of a newly constructed building being added to an existing building, stamps would be placed on both sides of the addition, treating the space as a sink choke. In the old building, it is possible to limit yourself to the installation of stamps at a distance of 15-25 m from the junction of the new building [16].

Methods for detecting subsidence of structures

Geometric niveliration method. The accuracy of determining the deposition of foundations of many identical andazali and tipovoy structures is ensured by the use of class I or II riveting methods. Only certain special methods of high-precision niveling are used in certain dive-noticeable structures.

The sinking of the fundamentals is determined according to special requirements in the method of class I nivelirning, using high-precision H-05 and compensator No. 002 (GDR) nivelirs, in the two horizons of the instrument in the correct and reverse direction, in geometric nivelir using barbed invariant rails. To reduce the effect of systematic errors of niveling on a dive, the same niveling in each cycle is performed in the path schematics and in the same program of measurement.

Sinking stamps are completed by starting with a boyllabic nivelling track starter (base) rapper and tying to the same rapper himself or another rapper. It is allowed that the length of the visor beam does not exceed 25 m, its height from the surface of the Earth or from the floor

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is not less than 0.8 m. In some cases, in the basements of buildings and when the length of the visor beam does not exceed 15 m, the height of the visor beam is allowed to be 0.5 m. Riveting is carried out in conditions where the image of the external environment is comfortable and the Reika barcode is clearly visible enough.

The Stamps, located inside the structure, are transmitted by a submachine gun transmission, window and door projections, not less than 0.5 m in diameter on the floor and walls. It is not recommended to install a nivelir between hot and cold air sails. Nivelir's angle I value should not be greater than, while the shoulder length difference in stations should not exceed 0.4 m.

The sum of the shoulder inequalities in the closed nivelirling pathway is allowed to be up to 2 m. The difference in relative heights obtained from the two horizons of the instrument should not exceed 0.3 mm.

In high precision nivelirning, the relative height measurement error at the station is on average 0.1 mm, while the nivelir track or polygon non-bonding check should not exceed the calculated value using the following expression.

$$f_{h_{I\,(mm)}} = 0{,}3\sqrt{n}$$

where n is the number of stations.

Under favorable external conditions for determining the otmetka of Fundamental rappers, strictly following the equality of the shoulders, it is necessary to perform the niveling at the high accuracy of the jihoz and also with strict attention to the installation of Reikes. It should be noted that, let's say, errors in the autographs of fundamental rappers, taken as two grounds, also distort the appearance of the occurrence of drowning.

From the fluctuating fluctuation of seasonal tribute, rappers otmetkas change significantly (up to 1-1.5 mm). Therefore, it is necessary to consider fundamental rappers and whether the observed Foundation is determined in the same conditions of ruin, or take into account the magnitude of this effect [17-20].

In large inbuilt construction sites, such as Seaplanes, a niveling track is placed on the base deep rappers in a class I niveling method to provide geodesic control over the sinking of individual parts of the structure. A Class II niveling track is placed between rappers with closed polygons or separate Yoles up to 1 km long, keeping a distance of up to 25 m from nivelir to Reika, and attaching all dipping stamps to them.

In most cases, the Class II method of niveling is used when observing the sinking of industrial structures. This method is performed using NI 007 (GDR) type nivelirs with flat parallel plate and adylate H-1, H-2 and compensator.

Niveliration is performed on a single instrument horizon, straight and in the opposite direction using a barbed invariant Reika (RH-05). Up to 2 stations of ruxst are provided on separate tracks.

The height of the visor beam should not be less than 0.5 m from the ground surface or foundation. The difference in distances from nivelir to reikas should not be greater than 1 m, for a closed path their sum should not be greater than 3-4 m. The length of the visor beam should not exceed 30 m.

The permissible non-bonding between the closed landfill or Class II points is calculated as follows:

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ISSN (E): 2942-1896 Open Access| Peer Reviewed

$$f_{h_{II\,(mm)}} = 1{,}0\sqrt{n}$$

where n is the number of stations.

Monitoring of subsidence in dams (plots) made of earth and stone, as well as in structures built on hard compacted soils, using H3 and Ni 007 type levels and two-sided centimeter piece (checkerboard) leveling method in the III-class leveling method. can be done. Leveling is performed in two horizons of the tool, in one direction. The length of the flashing light should not exceed 40 m. The height of the visor beam from the ground surface should not be less than 0.3 m, the difference in the distance from the level to the rails should not exceed 2 m, and their sum on the leveling path should not exceed 5 m.

The breakpoint of the grader path is calculated using the following expression:

$$f_{h_{III\,(mm)}} = 2{,}0\sqrt{n}$$

where n is the number of stations.[1].[3].[4].

Hydrostatic and trigonometric methods of settling

Application of hydrostatic leveling. Monitoring of foundation subsidence can also be done by hydrostatic leveling, there are two ways to do this: the first one is using a hydrostatic device that moves the marks of subsidence marks; the second, in a much improved order - by installing fixed hydrostatic systems along the perimeter of the foundation [17-20].

Application cases of hydrostatic leveling

Experiments show that hydrostatic leveling is mainly used for monitoring the vertical displacement of points of foundations and load-bearing building structures, in the conditions of narrow basements and workshops, where there are no conditions for convenient installation of the level and the operation of the observer, as well as a clear view of the monitored point. it is used in conditions with limited access, and also in buildings where human access is difficult or impossible depending on the production process.

Causes of the main errors in hydrostatic leveling

The main errors in hydrostatic leveling are caused by the influence of the external environment.

A change in the temperature of the external environment can cause an equal change in the temperature of the entire system and a change in the temperature of one or another pipe or a change in the temperature of the parts of the pipe connectors.

In order to reduce the effect of local defects on the accuracy of the hydrostatic system, it is necessary to place adjacent pipes in a horizontal position; the system must be protected from local heat radiation; it is necessary to ensure that the system is thermally insulated when measurements are made in the open air, and measurements should be made at night or during the day on cloudy days.

The most common fluid in hydrostatic systems is a fluid containing 0.1% formalin solution. At subzero temperatures, various alcohols or antifreeze liquids are used.

When determining the subsidence of buildings and structures, trigonometric leveling is used in conditions where it is difficult to use geometric and hydrostatic leveling methods. Such situations mainly occur in mountain conditions.

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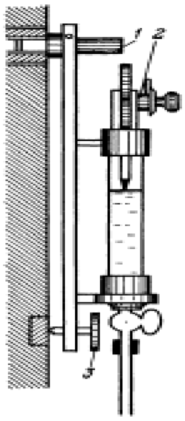
Trigonometric leveling is performed by using a reticle in a short-sighted light (up to 100 m).

Observations show that when T1 theodolite is used in favorable conditions, when the distance between the points is up to 100 m, the relative height is found with an accuracy of 0.2-0.4 mm. Vertical refraction greatly affects the accuracy of relative height measurement in the trigonometric leveling method. In order to reduce this, the measurement is carried out at different times, in several cycles [21-23].

. Portable hydros



1-metal rod ... luring measurem ... nark). 2nd measuring screw (using the t ... the still state of ... easure the scales) 3rd twisting screw (used to bring the pipe containers to the soap state according to the indicator) [24-26].

Results of building subsidence by leveling Placing stamps

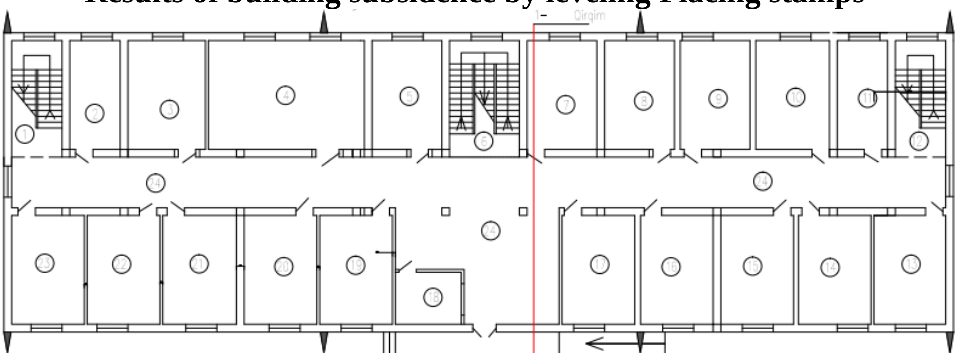


Figure 2. Building master plan

Baseline data and measured results for cycles

Table 1

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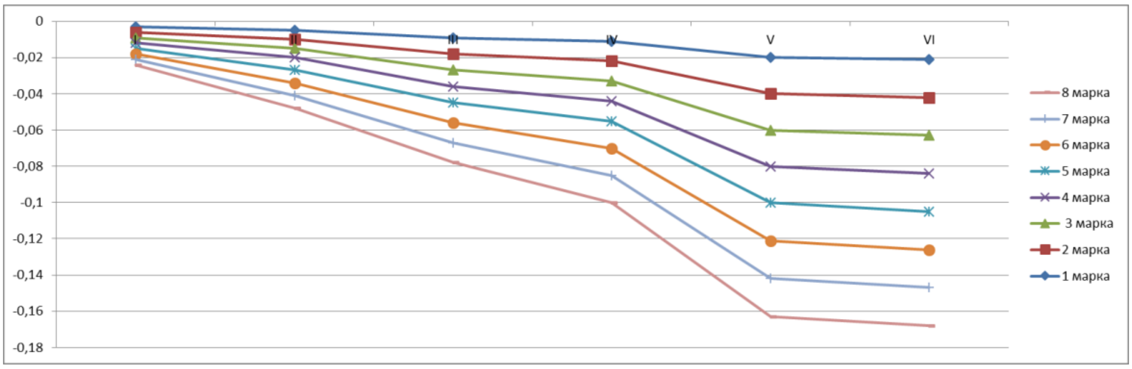
Brand number	*initial H0*	*initial H0 2020*	*Cycle I May 2020*	*II Cycle December 2020*	*III Cycle May 2021*	*IV Cycle December 2021*	*Cycle V May 2022*	*VI Cycle May 2023*
1	*129,32*	*182,321*	*182,324*	*182,326*	*182,330*	*182,332*	*182,341*	*182,342*
2	*129,321*	*182,321*	*182,324*	*182,326*	*182,330*	*182,332*	*182,341*	*182,342*
3	*129,321*	*182,321*	*182,324*	*182,326*	*182,330*	*182,332*	*182,341*	*182,342*
4	*129,321*	*182,321*	*182,324*	*182,326*	*182,330*	*182,332*	*182,341*	*182,342*
5	*129,321*	*182,321*	*182,324*	*182,328*	*182,330*	*182,332*	*182,341*	*182,342*
6	*129,321*	*182,321*	*182,324*	*182,328*	*182,332*	*182,336*	*182,342*	*182,342*
7	*129,321*	*182,321*	*182,324*	*182,328*	*182,332*	*182,336*	*182,342*	*182,342*
8	*129,321*	*182,321*	*182,324*	*182,328*	*182,332*	*182,336*	*182,342*	*182,342*

The results of sinking by coins

Table 2

Марка	*I*	*II*	*III*	*IV*	*V*	*VI*
1 марка	*-0,003*	*-0,005*	*-0,009*	*-0,011*	*-0,020*	*-0,021*
2 марка	*-0,003*	*-0,005*	*-0,009*	*-0,011*	*-0,020*	*-0,021*
3 марка	*-0,003*	*-0,005*	*-0,009*	*-0,011*	*-0,020*	*-0,021*
4 марка	*-0,003*	*-0,005*	*-0,009*	*-0,011*	*-0,020*	*-0,021*
5 марка	*-0,003*	*-0,007*	*-0,009*	*-0,011*	*-0,020*	*-0,021*
6 марка	*-0,003*	*-0,007*	*-0,011*	*-0,015*	*-0,021*	*-0,021*
7 марка	*-0,003*	*-0,007*	*-0,011*	*-0,015*	*-0,021*	*-0,021*
8 марка	*-0,003*	*-0,007*	*-0,011*	*-0,015*	*-0,021*	*-0,021*



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https://westerneuropeanstudies.com/index.php/1
ISSN (E): 2942-1896 Open Access| Peer Reviewed

Figure 3. Graphs of subsidence by cycles

Conclusion

It is important to measure the deformation of buildings and structures using geodesic methods. With these methods, the movements and changes that occur in different parts of the structures are determined. Geodesic methods provide accurate and reliable results because they employ high-precision measuring instruments and technologies.

The data received in the process of measuring deformation is analyzed and conclusions are drawn about the technical condition of buildings and structures. This information is important to ensure the safety of construction, to prevent possible risks in the process of operating structures.

Based on the data obtained using geodesic methods, deformations of structures are controlled and measures are taken to eliminate or prevent them. At the same time, this information is also used in the design of new structures and in the reconstruction of existing structures.

In conclusion, measuring the deformation of buildings and structures using geodesic methods is important in the process of construction and operation, and plays an important role in ensuring safety and quality. The introduction of geodesic monitoring, on the other hand, ensures that the facilities are reliable and stable in long-term operation.

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