DEFORMATION MONITORING OF MULTILEVEL RESIDENTIAL BUILDING DURING CONSTRUCTION

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Annatation: The article describes the technology of deformation geodetic monitoring of a multi-storey residential building during construction. The description of the main stages of work: the choice of the location of the reference frames and the assessment of their stability, the placement of deformation marks on the observed structure, the location of leveling moves along deformation marks, the implementation of several cycles of geodetic measurements and the determination of deformation marks observed by their results

The analysis of the obtained results has been performed, which suggests that at the time of the measurements, the observed deformation processes are predictable. Recommendations on improvement of the measuring measures complex are given, and the possibility of forecasting is considered, and the predicted values of the sediment deformation marks are calculated, which practically coincide with the actual values obtained in the next observation cycle.

Key words: deformation monitoring, multi-storey construction, precipitation of buildings, deformation mark, graph of sinking.

Introduction

The construction stage of monitoring is carried out in order to obtain and collect information about the possible negative impact of construction [1, 2]. At this stage, control and monitoring of the possible activation and development of deformation processes under the influence of technogenic factors arising during construction is carried out [3–4]. In this case, settlements of buildings and structures and horizontal displacements of buildings and structures are usually subject to control [5–6].

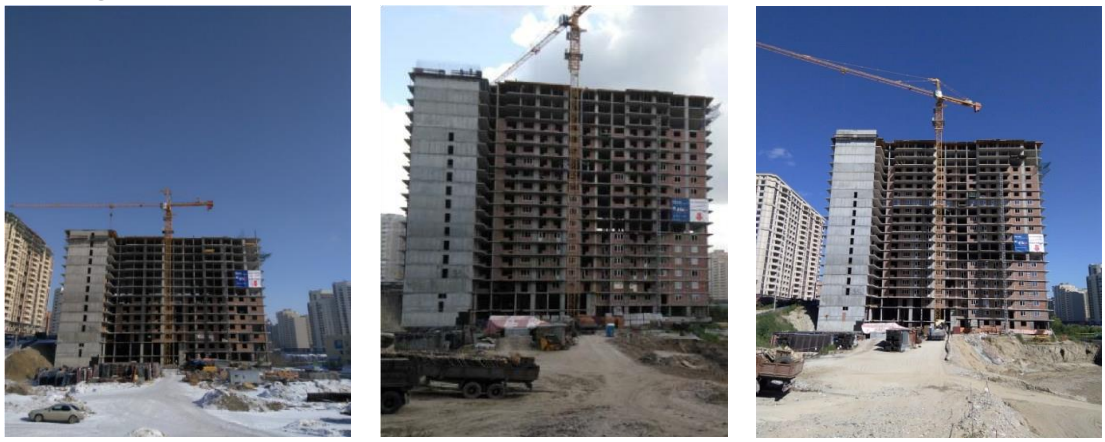
Monitoring of settlements of buildings and structures at the construction stage provides for control over the position of sedimentary marks and benchmarks of all objects. In these areas, control is carried out seasonally, up to 4 times a year. For processes whose activation is characterized by seasonality, control is carried out in accordance with seasonality. If necessary, with actively developing processes, observations can be carried out with an increased frequency: up to once a month [7].

Of particular interest in organizing the monitoring of structures are issues related to the interpretation of measurement results in terms of ongoing deformation processes, as well as forecasting changes in the displacements of individual grades and the development of deformation processes for the entire structure over time [6–7]. This article considers a set of geodetic works for the implementation of deformation monitoring of a residential building under construction, analyzes the results obtained, gives recommendations for improving the monitoring system, and also assesses the possibility of calculating predictive values of deformation marks settlement and determined from the value.

Methods and materials

Observations of vertical deformations (precipitations, rises) of the foundations of a building under construction were carried out for a multi-storey residential building on the street Izzat in Tashkent. The main purpose of the observations was to obtain data to assess the stability of the structure and take timely preventive measures to eliminate or prevent critical deformations.

Figure 1 shows a general view of the facility at various stages of construction and monitoring.



a) *b*) *c*)

Figure 1. General view of the object:
a) cycle 2; *b*) cycle 10; *c*) cycle 13

The work was carried out in two stages: field and cameral. The field stage included reconnaissance, laying and observation of 3 initial benchmarks of the high-rise foundation outside the zone of pressure propagation from the building under construction, as well as 15 deformation marks in the walls of the observed building, and preliminary processing of the leveling results.

The determination of the height position of the embedded marks was carried out with the leveling accuracy of class II [11]. The binding of the network of initial leveling benchmarks of class II was made to polygonometry point No. 12010 in the first (initial) cycle of observations in order to determine the marks of the network benchmarks in the local system of heights in Tashkent.

As an initial basis, a bush of wall benchmarks was laid, consisting of three wall marks, removed from the observed object at a distance of 210 m (regulated by regulatory documents - not less than 1.5 of the height of the object) [12]. In subsequent leveling cycles, the initial reference point when calculating elevations is taken to be that reference point on the site, the height of which, according to the results of the stability analysis, has changed insignificantly between adjacent cycles. The mark of this benchmark in the previous cycle of observations is taken as the initial one when calculating the marks of the benchmarks in this cycle [13].

The cluster of benchmarks (Pp1, Pp2, Pp3) was used from the first to the ninth cycle of observations. In the tenth cycle, the benchmarks were destroyed, and new ones (Rp1N, Rp2N, Rp3N) were laid as the initial basis with reference to polygonometry point No. 12010 [14].

The analysis of the stability of benchmarks and the calculation of their most probable marks were carried out by the method of V. F. Chernikov. The order of analysis and formulas are given in [15]. When leveling the results of leveling the second stage and calculating the marks and settlements of deformation marks, the most probable marks of benchmarks were used.

Deformation marks for determining the vertical displacements of the foundation are installed in the lower part of the supporting structures along the entire perimeter of the observed structure (after about 15 m), including at corners, joints of structures, on both sides of sedimentary or expansion joints, at the junction of longitudinal and transverse walls [16].

The layout of the initial benchmarks and deformation marks is shown in Figure 2.

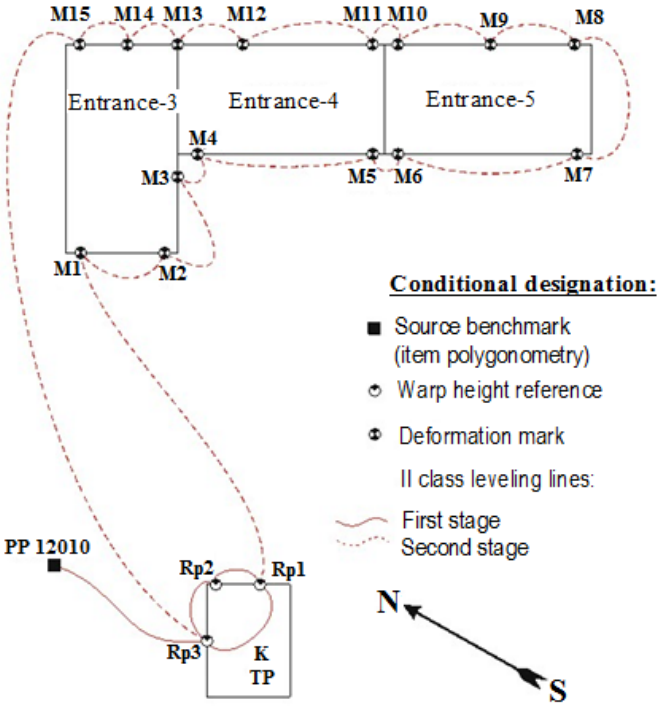


Figure 2. Placement of initial benchmarks and leveling lines

Leveling according to the initial network benchmarks and determining the height position of the embedded marks was carried out with a DNA03 digital level from Leica (Switzerland), which, complete with barcoded invar rails equipped with round levels, provides an RMS error of 0.3 mm per 1 km of a double leveling run. The observation cycle was once a month.В тринадцатом цикле в результате производства строительных работ оказались недоступными деформационные марки М7 – М14 и уничтожены марки М6 и М15.

At the office stage, processing, leveling and analysis of the accuracy of the measurement results were performed, schemes of leveling moves and a graphical representation of the settlement of deformation marks in the observed period were drawn up. Leveling network adjustment of class II was performed on a PC using a strict parametric method using a certified software product Level 1.1 from Credo-Dialog.

A search was also made for the predictive values of the marks of deformation marks. To this end, the ratio of the mean square error to the mean measurement error was preliminarily estimated after each cycle of observations. Based on this criterion, a decision was made on the possibility of determining the predictive values [8, 10].

Results

The analysis of the residuals obtained shows that all the residuals are much less than the allowable ones, thus, the final accuracy assessment from the adjustment showed that the leveling performed by class II in terms of accuracy meets the requirements of the current regulatory documents [11, 17] and the marks of control points are determined with sufficient accuracy.

According to the adjusted marks of sedimentary marks, their sediments between adjacent cycles of observations were calculated

$$S' = H_i - H_{i-1}, \qquad (1)$$

where H_i – mark of the sedimentary mark in the *i*-th cycle of observations;

H_{i-1} – mark of the sedimentary mark in the (*i*–1)-th cycle of observations [15]. Based on the data obtained, detailed sediment graphs were built (Figure 3).

Such graphs allow you to visually judge the size and uniformity of the sediment.

Also, bills of sediment were compiled by blocks for symmetrically located marks and their graphics [7].

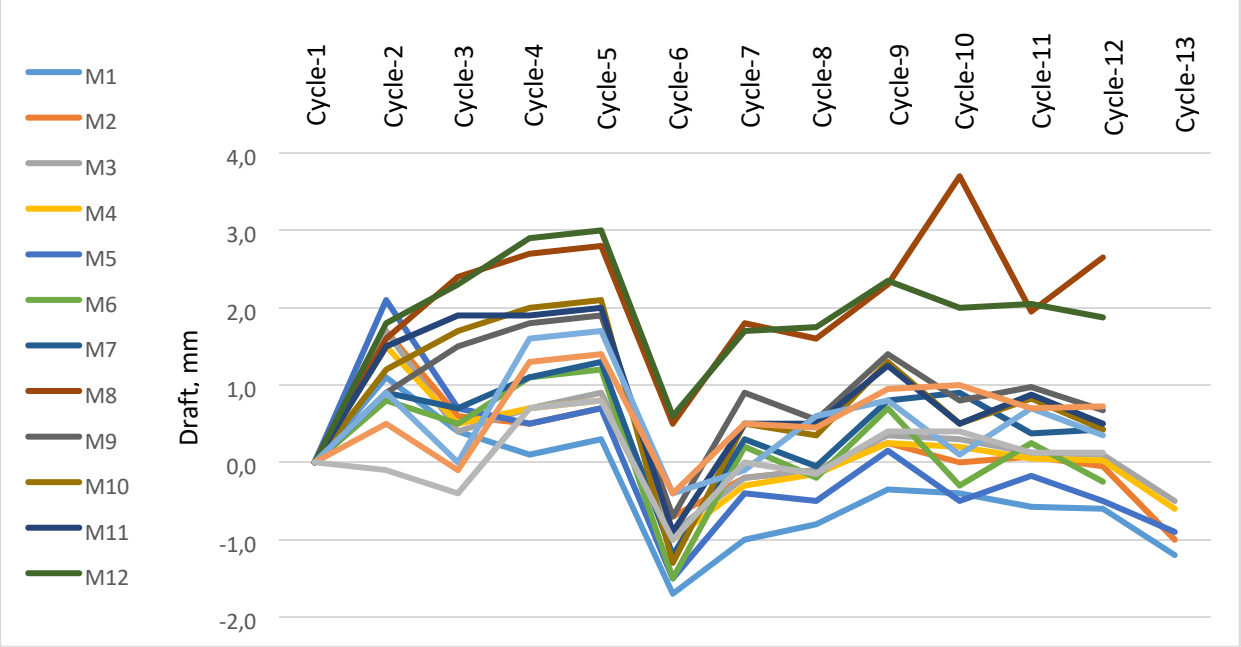


Figure 3. Expanded graph of sediment relative to the initial cycle

After each measurement cycle, a coefficient was determined that estimated the ratio of the mean square error to the average measurement error; in the absence of jumps in the values of the coefficient, we can talk about the absence of qualitative changes in the state of the construction object, which makes it possible to determine the predicted values of the deformation marks settlement [8]. In our case, the value of the coefficient practically did not change and amounted to 1.16 for all observation cycles.

Discussion

The analysis of the settlements showed that from the first to the thirteenth cycle (February-August), the precipitations are almost unidirectional, uniform, insignificant and range from -3.4 to +3.7 mm, with allowable values of maximum settlement for civil multi-storey buildings with a full frame and a monolithic overlap - 20 mm.

After each measurement cycle, the exponential smoothing method was used to calculate the predicted values of deformation mark settlements, which practically coincided with the actual value determined in the next observation cycle. The maximum discrepancy between the predicted and actual settlement values was 0.3 mm.

The coincidence of the predicted and actual values of the sediment marks indicates the regularity and predictability of the development of deformation processes during the construction of this structure.

Conclusion

The performed studies allow us to say that at the time of measurements, the observed deformation processes are predictable and do not pose a danger to individual structural elements and the structure as a whole. For further monitoring of the object, it is necessary to lay down the deformation marks lost in the thirteenth cycle.

Observations of the deformations of structures are a set of measuring and descriptive measures to identify their magnitudes and causes. Therefore, it is also recommended to expand the range of field work and include measurements aimed at determining the planned position of deformation marks. This will allow in the future to monitor the horizontal shifts of the observed object, which are possible due to further loads from the rise of the floors and the direction of the soil slope.

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