ANALYSIS OF MODERN GEODETIC AND GEOTECHNICAL METHODS OF MONITORING THE STRUCTURES DEFORMATION

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Keywords: deformation monitoring, inclinometer, GNSS

Problem

Currently, intensive technical progress the issue of choosing the method of monitoring the deformation of engineering structures give special attention. This is due to the rapid development of high-precision instruments and software packages used for processing the results of observations. So urgent is the task to analyze the current state of technological features of these methods and means of their implementation.

How to important scientific and practical tasks

During operation of engineering facilities necessary to carry out high-precision monitoring of deformations. The study is important to determine the speed and direction of strain, which is why it is so important to choose the optimal method of monitoring [4]. Therefore, the study of these methods will select such a monitoring technology that would provided accurate information about the behavior of buildings.

The Problem

Perform analysis of the literature which highlights techniques, methods and algorithms for monitoring deformation processes. Make the appropriate conclusions.

The main material

Today there are several research methods deformation structures. Table 1 shows the most common ones.

Each of these methods is based on obtaining data from various geodetic instruments. Investigations of use requires precision surveying instruments and accessories. Table 2 shows the recommended models of modern geodetic instruments and their accuracy.

Consider literature, which investigates the methods listed above. In [9, 10] presented a method for monitoring deformations skyscrapers based on GNSS-data and accelerometer measurements [13]. The study was carried out on the roof of a skyscraper «Yokohama Island Tower» in Tokyo. Instruments were installed on the roof of buildings and worked in continuous mode. Figure 1 shows a placement of devices on site.

The data elaborated together. With the processing results of observations we can conclude that GPS measurements are in good agreement with measurements of the accelerometer. But it should be noted that the GPS-measurements contain error basis, because the distance between the pair of devices was 34 km.

Another skyscraper is investigated Komtar Tower in Malaysia. The study used strains network of 6 stations GPS-4 - on the roof of the building and 2 - on the square in front. The authors [13] performed only two cycles of observation, which is not sufficient for reliable conclusions regarding the behavior of structures.

This publication [5] for a more detailed description of the structure and characteristics of operation inclinometer series NIVEL 200 Swiss firm Leica. Attention is focused on precision observational results obtained in the measurements during different modes of operation. The results of measurements are processed in the software package GeoMos, but simple controls allow teams to create their own software modules to address specific surveying tasks. NIVEL 200 has the ability to create a network of measuring up to 32 devices, allowing you to explore the deformation of extended objects holistically.

In [7, 8] performed research dam deformation Kabril (Portugal). At the dam cycles are performed annually using GNSS observations and linear-angular methods. When performing a new cycle of observation gallery on the upper dam was used inclinometer, who worked in cont two days. Analysis of the results showed a correlation between the dam body movements and daily fluctuations in water level in the reservoir.

The authors of [2] focused on the causes of deformation structures and the need to perform

periodic monitoring of structures, due to the increasing number of accidents. In this paper highlight the most promising, according to the authors, methods of monitoring, namely monitoring structures using electro-optical systems, geodesic monitoring using electronic total stations, the use of laser scanner during photogrammetric measurement methods, geodesic monitoring by satellite geodesy using navigation systems GNSS, method photofixation defect monitoring using dynamic testing methods hydrostatic video monitoring. The description of these methods and conditions of use.

Analyzing of materials should be noted that the publication is considered the methods combining a number of ways of monitoring, which greatly simplified the production process.

Definition lists engineering structures terrestrial laser scanning method discussed in [3]. From a technological point of view laser scanning method is much faster and easier than with other methods of research deformations. The main part of this method is office processing, which is a cumbersome procedure, because with all the cloud of points necessary to allocate the object, dismember it into graphics primitives, as automatically build a 3D model of the building complex forms impossible [12]. The authors performed the study for the construction of a rectangular shape, which greatly simplified the process of data processing, but for more detailed studies of technology necessary to carry out inspection of buildings with complex geometric shapes.

Another deformation monitoring technology plants is shown in [15]. This method is precision leveling marks, which are located on the perimeter of the basement structures. Based on the difference marks Marks are analyzing the absolute values of strains and their rate of change. It should be noted that to determine the rate of change of strain such research should be carried out regularly and for a long time.

The method is linear-angular measurements investigated territory Yamula Dam (Turkey) [6] and caste Dam (South Africa) [11]. The observations were carried out in several cycles using high-precision total stations. The method allowed to observe deformation during the dam associated with raising water level in the reservoir.

The object of studies [1] is the sarcophagus of Chernobyl. Observation of deformation structures conducted since 1987. Determined vertical displacement (subsidence) control marks embedded in the basement of buildings by repeated precision geometric leveling, and horizontal and vertical displacement of the upper tiers of brands and roofs - by repeated determinations of spatial position straight and angled Serif trigonometric leveling. Detailed speed and direction strain sarcophagus. Analysis and comparison of measurement results on a long period of time, which revealed maximum drawdown (40 mm) and horizontal displacement (20 mm).

Findings

1. Analyzing reviewed publications should be noted that studies deformation structures topic is relevant and widely covered in modern publications.

2. Study of deformation structures perform traditional methods, but to achieve more reliable results should combine different monitoring methods.

3. Shows the devices to sufficient accuracy for monitoring deformation process works.

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Analysis of current publications focus on the study of engineering