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ANALYTICAL REVIEW OF METHODS OF MONITORING INDUSTRIAL OBJECTS AND POSSIBILITIES OF THEIR COMPLEXATION

The article deals with the analytical review of methods of monitoring industrial objects. As the title implies the article describes the main objectives of the system of monitoring and its basic creation principles. A general diagram of some steps of the observation process has been presented. It is reported about the latest achievements in this field (Leica Nova MS50 MultiStation). Also, it has been concluded that there is a need in complexation of different monitoring methods, depending on the properties of the object.

Keywords: *monitoring system, complexation of monitoring methods, MultiStation.*

Introduction

Current trends in constructing large cities, namely the increase of the number of storeys in buildings, the urban area density, the tightness of construction sites, the reclamation of unfavorable locations for building up and the saturation of underground space with services ultimately lead to the emergence and subsequent increase of negative technogenic effects of construction on earlier built objects located in the surrounding areas. In this connection the organization of monitoring technical condition of buildings and structures gains a special importance. According to the results of the observations made the accuracy of design calculations has been verified, and the regularities, allowing to predict the process of deformation and to take measures to eliminate their consequences in proper time, have been defined.

In engineering geodesy the term "monitoring" means a regular (held at regular intervals) control of changes in condition of buildings, constructions or other engineering structures [1]. Control of the technical condition of the objects being observed must be provided systematically and must also allow to accomplish the estimation of the changes that take place on the basis of quantitative criteria. Construction process monitoring is based on the procedures of identifying the conformity of actual values of displacement, subsidence, tilt, etc. with the regulatory requirements, and on the further forecasting of the trends in their development.

The main objectives of the monitoring process are:

– to determine the absolute and relative values of deformations;

– to identify the causes and the risk level of deformations;

– to characterize stability and reliability of foundations;

– to establish the limit values of deformations;

– to predict the development of deformation processes,

– to warn possible risks;

– to take timely measures against the emerging deformations and to eliminate their consequences.

In case of erection complex, high-rise constructions the monitoring process begins at zero cycle. This is connected with the analysis of natural factors affecting the possible deformation of the object and the establishment of geodetic backbone networks. General form a monitoring system fig. 1shows.

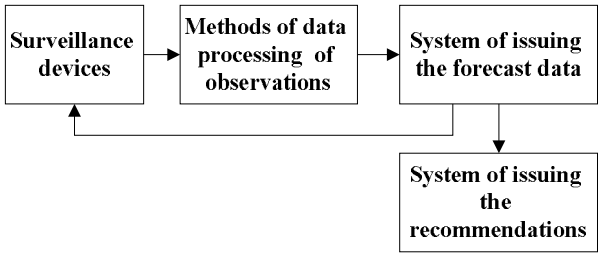

Fig. 1. General view of a monitoring system

Tasks and objectives

Any construction is exposed to various kinds of deformations, the most important of which are determined by measuring the degree of relevance. Despite the wide range of observation methods the specificity of the organization of monitoring works in volves the overcoming a number of difficulties related to the operating conditions and environment, as well as to the physical properties of the object of observation. Exactly in order to take a full control over the stability condition of a building or a structure, it is necessary to resort to the complexation of different methods of monitoring.

The complexation of monitoring methods involves combining different technologies to collect information about the object and creating a system generalizing the results of observation for view issuing a single result.

The latest achievement in this area is a multistation Leica Nova MS50, shown in fig. 2.

This device combines capabilities of a tacheometer, a laser scanner, a high-precision GNNS receiver and high

resolution camera Such devices as Leica Nova MS50 notably simplify the process of monitoring of multicompound (overpasses), saturated objects with communications (industrial workshops), high-rise objects.

Fig. 2. LeicaNovaMS50 MultiStation

Complexation of monitoring methods

Most often we combine data obtained by means of geodetic devices and various types of sensors. This allows to estimate the parameters of the displacement of the construction relative to the forces applied. Thus, it is possible to take timely measures and prevent the damage of constructions.

The method of geodetic observations in cludes application of GNSS-technologies and high-precision geodetic equipment. The obtained data corresponds to the condition of the construction when being measured. Thus to obtain reliable information about the dynamics of behavior of objects some systematic measurements are required. For this purpose highly accurate, reliable and well-protected tacheometers with servo-motors, which allow measuring parameters automatically at a predetermined frequency are used. GNSS receivers are used both for monitoring parameters shear and slump, and for obtaining the coordinate corrections.

The determination of the list is accomplished by means of vertical projection devices (see fig. 3).

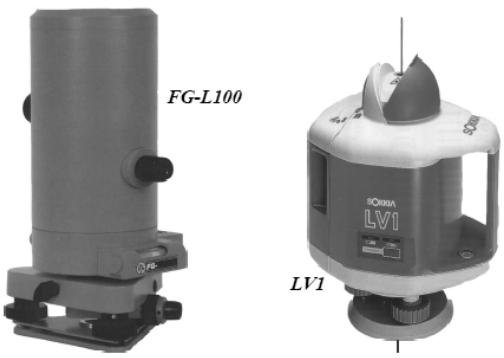

Fig. 3.Optical device FG-L100 and laser device LV1

Such devices are intended to form a plumb axis of sight or a plumb laser beam in space. Under favorable conditions optical devices for vertical projection guarantee the accuracy of 1-2 mm for 100 m. The accuracy of laser devices averages 15 mm for 300 m, and the range of projection can make up to 600 m or more.

By solving the problems of engineering-geological observations it is possible to apply a set of schemes both of different complexity and cost and of different resolving capacity and information content of the measurements in individual wells to interwell translucence. Depending on the type of sensor, it is possible to conduct monitoring of differential (layerwise) or total sediment of the basement soils and water level. In addition to the wells the important information is obtained by placing a network of soil pressure detectors under the base plate, and the vertical load detectors are placed in piles.

During the seismometric measurements schemes of observations include some variants of oscillation excitation of buildings by both artificial (strikes) and natural (wind, seismic jolts) sources. Seismometric measurements provide a "momentary" picture of object condiction, that being observed temporally can give various information about the features of the dynamics of the construction.

When monitoring objects full with complex architectural elements the application of stereophotogrammetric methods and laser scanning systems takes place. It allows to get the most complete and detailed picture for building 3D models as well as for 2D drawings used for possible restoration.

The main advantage of laser scanning technologies is a huge array of spatial data in the form of a "point cloud" when shooted. Fig. 4 shows the results of the evaluation of the reservoir deformation.

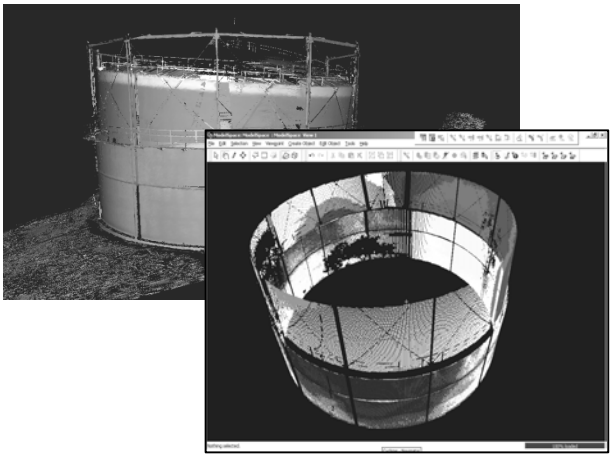

Fig. 4. Point cloud of the reservoir

This redundancy of data allows to get an incredible detailing of the object observed and significantly to reduce the time of shooting. There is a sufficiently large variety of scanning systems which differ in scanning speed, distance and cost.

Photogrammetric method allows to determine deformation arising in the plane and is used for studying

flat objects. The idea of the method is the following: from one and the same fixed point several images of the observable object can be obtained, for example the first image – before the load, the second – during the load and the third - after the load. The camera is set in such a way that the plane of the registering frame is applied parallel to the plane of the object and the elements of the orientation of images are preserved.

Stereophotogrammetric method allows to determine the deformation that occurs in space and is used for studying spatial objects. From one and the same basis several stereopairs of the observable object can be obtained, for example, the first – before the load, the second - during the load and the third after the load is removed.

Regardless of the choice of the method of observation the basic stages of monitoring can be distinguished (see fig. 5).

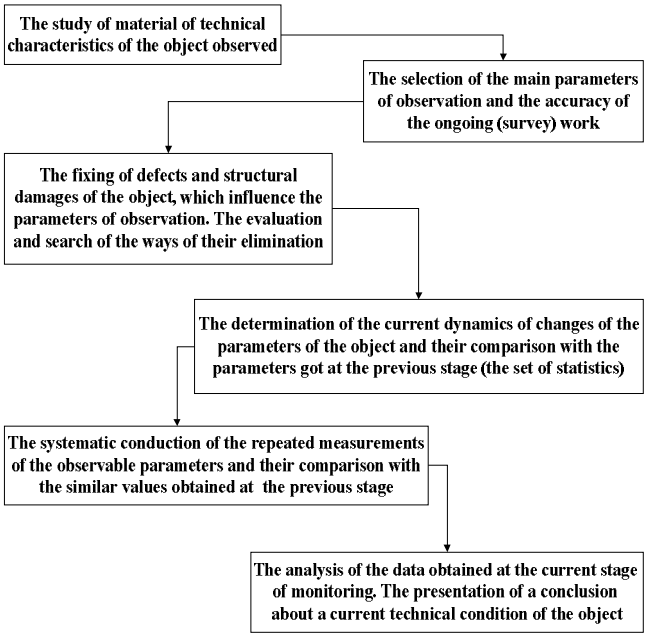

Fig. 5. The scheme of stages of the monitoring

Conclusion

The result of the complete cycle of monitoring process must become data sufficient for preparing a well-grounded conclusion about the current technical condition of a building or a structure and issuance for providing a short-term prediction about its condition for the forthcoming period.

When creating a complex method of observation it is important to take into account the following criteria:

- physical properties of the object;
- location of the object;
- frequency of observations;
- degree of the accuracy of measurements;
- type of the provision of resulting data.

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АНАЛІТИЧНИЙ ОГЛЯД МЕТОДІВ МОНІТОРИНГУ ПРОМИСЛОВИХ ОБ'ЄКТІВ І МОЖЛИВОСТІ ЇХ КОМПЛЕКСУВАННЯ

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Проведено аналітичний огляд методів моніторингу промислових об'єктів. Розкриваються основні завдання системи моніторингу та основні принципи створення даних систем спостереження. Приведена загальна схема етапів процесу моніторингу. Представлена інформація про останні досягнення в даній області (LeicaNova MS50 MultiStation). Крім того, було зроблено обґрунтований висновок, що існує необхідність в комплексуванні різних методів моніторингу, в залежності від характерних властивостей об'єкта.

Ключові слова: *система моніторингу, комплексування методів моніторингу, MultiStation.*

АНАЛИТИЧЕСКИЙ ОБЗОР МЕТОДОВ МОНИТОРИНГА ПРОМЫШЛЕННЫХ ОБЪЕКТОВ И ВОЗМОЖНОСТИ ИХ КОМПЛЕКСИРОВАНИЯ

Д.И. Ерёменко, Л.М. Бабакова

Проведен аналитический обзор методов мониторинга промышленных объектов. Раскрываются основные задачи системы мониторинга и основные принципы создания данных систем наблюдения. Представлена общая схема этапов процесса мониторинга. Представлена информация о последних достижениях в данной области (LeicaNovaMS50 MultiStation). Кроме того, было сделано обоснованное заключение, что существует необходимость в комплексировании различных методов мониторинга, в зависимости от характерных свойств объекта.

Ключевые слова: *система мониторинга, комплексирование методов мониторинга,MultiStation.*