

ANALYSIS OF METHODS OF PREDICTING PIT WALLS AND WASTE DUMPS STABILITY

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Abstract: The main methods of observation and forecasting stability of open-pit mining is given. Problems of geotechnical processes are extremely complex and multifaceted problem which solution is impossible without a multitude of scientific problems due to the general course of scientific and technological progress in the theory and practice of open pit mining. Based on studies of actual performance pits and dumps it was reasonably significant and important to predict, an important aspect of the prospects of slopes condition that is important for the duration of their service. As a result of the comparative efficiency characteristics of existing methods and controls, the basic advantages and disadvantages are made. Analysis of theory and practice on the methods and means of implementing the operation prediction of iron-ore deep pits, led to the conclusion about the necessity of modern technology use in all types of surveyor-geodetic work that will improve operational and surveying records of open pit mining and mining operations, effectiveness observations deformation and loss of minerals.

Key words: geotechnics, mining, pit, mining operations, surveys, geodesy, monitoring, prediction, stability.

Introduction. The introduction of new and existing automated methods of forecasting steady state of open-pit mining is a hot topic for the mining industry. Methods and tools that have been developed a few years ago are now outdated, they have been replaced by more accurate, more efficient, improved and automated ones. Today surveyor or geodesist is facing a problem of using the correct choice of method and the method of forecasting steady state of rock mass. Therefore, to overcome this problem it is proposed to perform a comparative analysis of existing methods of observation used in Kryvyi Rih basin (Kryvbas) enterprises.

Materials and Methods. Today there are many methods and automated control systems, all of which in one way or another perform the task. The labor market is represented by a large variety of modern devices for observing the steady state of mining. Powerful enterprises every day are seeking ways to improve and upgrade existing facilities for observations. However, the forecast assumes a reliable measurement of baseline data to assess future sustainability pits and dumps walls, part of which is to establish the form and position monitoring slip surface in rock mass based on it, by interpreting the results of the methods of monitoring the displacement of work rappers located on the sides of the berm of dumps and pits. The most significant deviation in the

determination of the time of a possible shift or when determining the shape and position of the salient occur in the central parts, performance and impact of which can lead to errors in study design and assess the stability of pit walls and overburden dumps slopes.

Results. Selecting the most accurate method of predicting the stability of pit walls and dumps that require minimal cost to use is one of the most important parts of the process of observations of the rock mass. Monitoring of slopes is carried out while performing mining operations to front pit contours. In fact, status of monitoring slopes is a process of compliance between current measurements of geotechnical parameters and pre-determined rules. The main objective of observations is - detection mechanism landslides and setting the most important parameters of slope deformation. The observations reveal the full amount of the aggregate effect of factors that affect the stability of slopes and pits sides. Efficiency and quality prognosis depend on the speed and accuracy of obtaining background information on surface displacement near pit walls massif.

In Ukraine, experts use a wide variety of methods for predicting the steady state of open pits, the main ones are: visual; engineering and surveying; engineering and geophysical; instrumental; geotechnical; engineering and hydro

geological; hydro geological methods [1-2]. The analysis of modern methods of monitoring and control, as mining regions in enterprises of Krivbas allowed forming a table, with which there is an opportunity to review a comparative analysis

to ensure credible decision on the choice of a particular method [3-4]. There has been established a comparative description of methods of forecasting a steady state of open – pit mining and presented in Table. 1.

Table1. Analysis of efficiency of monitoring the stability of pits and dumps walls methods

Method	Method's advantages	Method's disadvantages	Characteristics of the method
visual	allows to estimate the field of use of the results of instrumental, geophysical and engineering, geological condition of slopes	only part of the complex methodology of slopes conditions study	fixation method is visible on the surface manifestations of abuse for slopes, the character of massif fracturing, water occurrence and effects of blasting
surveying-geodetic	gives a quantitative estimate of the slope deformation, reveals the nature of early strain that allows you to make prediction about its development over time	requires special tracking station	fixation method is to obtain quantitative and deformation patterns on the surface of slopes and deep massif on the results of measurements of horizontal and vertical displacement of sediments
engineering and geophysical	allows fast and efficient way to find the beginning of geotechnical processes	does not give a definitive statement about the state of the slopes, it can be done only on the basis of geological and hydro geological observations	method gives data to determine the development of deformation processes and their speed
instrumental	developed hardware, some technique work, counting system of coordinates, a high degree of safety work	used only to monitor the stability of profile lines on the walls	fixation method is to obtain quantitative and deformation patterns on the surface of slopes and depth of massif on the results of measurements of horizontal and vertical displacement of sediments
engineering and geological	acquires a leading role in the formation of soft and rock dumps on the weak base	their use depends on the degree of rocks compaction in the dumps	fixation method is to change the distribution of physical fields (electric, magnetic, electromagnetic, etc.) related to the presence of hidden slope slide, changes in physical, mechanical and physical properties of rocks
engineering-hydro geological and hydro geological	rapid determination of properties of rocks, comparison of actual performance with calculated, document cases deformation of slopes and necessary amendments in the design and development of specific additional measures to ensure the slopes stability	lack of experience in the application for the task, the need of additional research for such cases	methods for determining the position of the depression curve in the rock mass, measurements inflows of groundwater in areas of leak and perform measurement of steam pressure

The complex tectonic structure in a number of mining regions, caused by a significant increase in the depth of development requires fundamentally new devices to monitor landslide of rocks, characterized by high accuracy in forecasting and their relatively simplified design. This is due to the specifics of these works. High precision requires improved speed performance prediction of mine workings stability and balance of records of industrial reserves. The current practice of mining enterprises in Kryvbas shows that at the moment of observation and measurement of the pits are performed by using tachometry, leveling, use of GPS systems, etc. [5, 6].

The devices used for geotechnical monitoring of open-pit mining in the territory of Kryvbas are: electronic total stations; GPS systems; remote methods (digital terrestrial survey); optical and electronic levels; electronic stations; laser rangefinders; laser scanners; radar control systems.

The qualitative leap towards a tool for building 3D models was made with the advent of no reflected measurement systems and of development based on these three-dimensional laser scanning systems. The use of these techniques allows obtaining significant advantages both in technological and economic aspects [7].

Practical application of high-satellite GPS receivers to determine the strain state of open pits,

allowing you to shoot, which significantly reduces both the time of operation and processing results. This was the first step in developing basic methodological approaches of GRS filming for the control of strain state of open –pit mining. The use of GRS in Kryvbas pits allows: to abandon the inclusion of the relevant lines of observation stations supporting frame close to the observed rock mass (reference point differential correction may be at a distance of 5 kilometers from the line

profile), which in turn increases accuracy of measurements; significantly expands the boundaries of the study area, the impact of mining operations, which ultimately allows you to study the deformation of the upper crust caused by human activity at a upgraded level [8].

Ordering of technical means for monitoring of geotechnical steady state of open-pit mining is shown in Fig. 1.

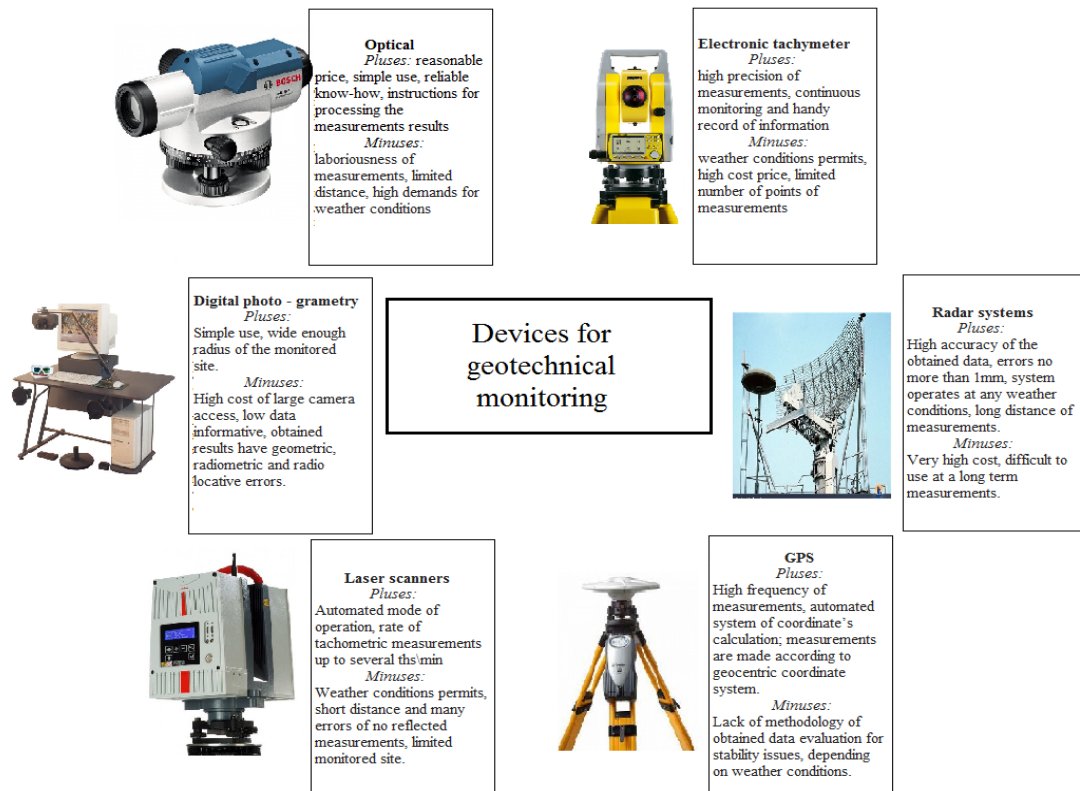


Figure 1. Devices for geotechnical stability conditions monitoring of open-pit mining

Nowadays, the most common method of correction of the satellite signal is the method of differential correction. This method is based on the accumulation of data for differential correction at the base, which consists of a receiver with antenna, computer and related software. Mobile GPS receiver also collects data in its own memory in a volume sufficient for further correction information. After work completion the data base and the data from mobile GPS receiver are jointly processed using special software.

The use of radar control systems (SSR) - Ground Probe can be called the latest science and technology achievement in this field. The purpose of monitoring using radar surveillance systems is to

reduce the risks of disasters and reduce their possible effects due to early detection of displacements and deformations of the earth's surface at the surveyed areas.

Conclusions. To improve the efficiency of supervision, deformation in mining regions of Kryvyi Rih special place is devoted to the effective implementation of new devices for automation mining processes. The task of improving the methods of measurements and interpretation of fractured rocks in the pit walls, mines, dumps, boreholes is quite relevant today. Overall, the forecast of stability of open-pit mining, surveying observations of rock slides is the most reliable because it is based on objective information on the

status of mining massif. But its use is faced with production and economic problems to get real deformation data of rock slopes. This necessitates the involvement in the field and desk surveying of modern surveying equipment to monitor the stability of benches, pit walls and dumps.

The introduction of new information and measurement systems on territory of Kryvyi Rih led to automation of most processes and ease of processing. So, important is the creation of the system of automatic stability control boards in pits and dumps, some of the first systems have already been developed, passed laboratory tests and are ready to being implemented in mines. In terms of "cost - effectiveness" and the quality of the information, the use of GPS technology to obtain information about the strained state of rock mass to predict their steady state is far the most appropriate.

Problem of stability control of by-walls massif in Kryvbas pits can be solved only on the basis of an integrated approach that includes all components of the solution of problems and issues that have been discussed in this article.

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