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Assessment of the Strength of Rocks in Open Mining Processes in Mining Enterprises

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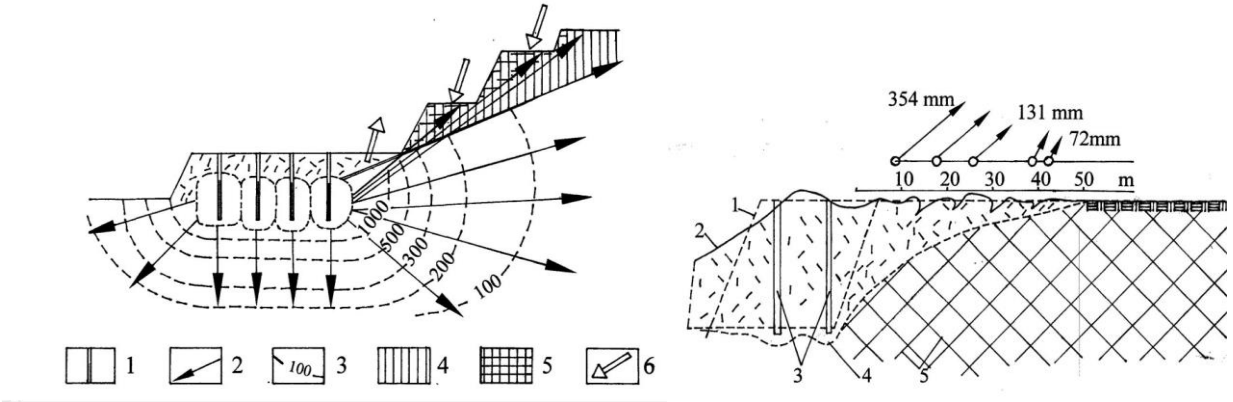
Abstract: The article presents the results of experimental studies on the strength characteristics of the rocks used, the results of studies on the assessment of the stability of the slopes of the open pit mine. Formulas describing the relationship between ultimate and residual strength and residual shear strength of rock samples along the relief surface are determined. Based on the test data, a new method for calculating the residual interface strength of rocks was developed, which was tested on small-sized monolithic samples at opposite technological depths. The strength assessment method is the recommended characteristics of the rock mass near the broken slope (structure attenuation coefficients and internal friction angles). The method relies on test data obtained by breaking small-sized monolithic specimens with a technological recess, taking into account contact conditions along the weakening surface, and can be used in field conditions. In opencast mines, slope instability has a negative impact on the overall profitability of the mine and can also affect safety and the environment. The geometry of the slope has a decisive influence on the slope of the open pit, the quality of the rock mass and the presence of geological features and their characteristics should be studied. The purpose of this study is to show how to choose the optimal general slope angle of mines and according to three design parameters, namely safety (for example, the probability of instability), performance (for example, profit) and mining costs (for example, overburden removal).

Keywords: Slope stability in mining enterprises, coefficient of strength of rocks, open pits, technique of reducing the cutting force of rocks, productivity of open pits.

Introduction

In the assessment of slope stability in open mines, the primary data are represented by physical and mechanical properties of rocks. However, their evaluation in field conditions is very labor intensive and high-level interpretation of the obtained results is a difficult process. Therefore, preliminary data are determined by correcting the results of laboratory tests for empirical correlation, taking into account the characteristics of rocks with unnecessarily large structural dimensions. In Uzbekistan, this phenomenon is characterized by the term "solidity coefficient of rocks", the relationship between cracks and surface irregularities, especially the cases related to their expansion, is given great attention. In addition to the development of computers and special programs aimed at evaluating the stability of open pit slopes, practical calculations are also actively involved. This allows for a more complete and detailed review of the structural composition of rocks in mining enterprises. The combined use of empirical correlations derived from scale effects and prospective slope modeling with detailed structural content can lead to double counting of rock fractures. On the other hand, approaches to scale effect estimation using numerical modeling are increasingly developing. The slope angle has a greater or lesser effect on the calculation ratio, and this leads to the profitability of the mine. Alternatively, the higher the

processing speed, the more expensive and less profitable mining is. Lowering the mining rate (e.g. removing less waste rock) requires keeping the overall slope angle as steep as possible (e.g. increasing ore recovery) is preferable. This requires successful pit planning and accurate knowledge of geology and site characteristics. The final design of the optimal angle of the slope is determined not only by the costs of ore distribution and operation, but also by the characteristics of the total rock mass. Therefore, it is recommended to include the possibility of failure in the final design of an open pit mine. It helps to predict temporal and spatial movements. Stone properties are important design input parameters. These parameters are never known with certainty. There are always uncertainties associated with this, which cannot be eliminated. Some of these uncertainties include limited data, testing errors, haphazard data collection, and lack of knowledge that can cause problems. Probabilistic methods are introduced here, the next section is used to address the uncertainty associated with rock mass properties. Probabilistic methods are used to deal with the strength/structural variability associated with rock properties. They are used to evaluate the probability of failure and different slope angles, and measures should be taken to reduce the risk to an acceptable level. These methods involve statistical variation of numerical model parameters (eg, mean, variance, and standard deviation) representing rock mass properties, and rock loss criteria are considered as design. In this study, our focus is on the uncertainty arising from the properties of the rock mass. In underground mines, several mining levels are usually active simultaneously at different depths to improve production. The mining process creates redistributed stresses that can be transmitted horizontally and vertically. Therefore, this study is an attempt at a hybrid approach combining numerical modeling and probabilistic analysis to evaluate the stability of an open pit mine at different total slope angles. A two-dimensional elasto-plastic finite element was used to develop a series of models at different slope angles. Rock crushing and grinding, we can observe the processes of applying methods of reducing the cutting force. The results show that mine profitability and overburden removal costs increase and decrease with steep overall slope angle. However, the stability of the slope deteriorates. Therefore, it is recommended to combine these three design parameters (such as safety, performance and cost). Care must be taken when choosing the general slope angle of open pits. Transferred stress can cause stopes to fail and damage mining equipment. To ensure the safety of the mining zone, sill pillars are usually maintained to prevent the transfer of redistributed stress, especially in ores at steep depths. In most cases, vine pillars are restored to extend the life of the mine and maximize the use of minerals. Pillar reclamation is the practice of developing several pillars and then mining the pillars, which is the most dangerous form of underground mining. It can present hazards such as rock subsidence, stalling, and pole failure during pole restoration. Scientists have developed and proposed empirical, analytical theories, and numerical modeling methods to better assess the stability and improve the safety of miners and mining equipment during tabletop restoration.



Picture 1. Strength coefficient factor in rock mining

The main method of drawing up the rock strength certificate involves calculating the characteristic points of the envelope and the parameters of the strength certificate using the functional properties that determine the destruction of the rock mass. In the absence of normal

stress, the tension st and compression p components of the peak shear resistance are assumed. The crushing strength of the rocks along the contacts was compared and it was found that the impact strength of the rocks was the smallest of the parameters. The difference between the strength of rock and the residual strength of fractured rock increases. Comparison results between final and residual strength of monolithic rock calculated using the results of spherical indicator tests. Demonstrates the application of ultimate and residual strength calculations using rock volume tests and a straight-line approximation of the envelope segment corresponding to the shear mechanism of the estimated parameters. Ultimate stresses should be calculated for a wide range of comparisons. Research on Blast Hole Drilling Equipment Selection and Performance In recent years, great progress and capital investment have been made in the development of coal mining equipment for both longwall and room and column rigs. This development inevitably led to a significant increase in mine production. In many cases, this improvement in production efficiency highlighted the inefficiencies of outgoing belt conveyor systems. As a result of this improvement, the requirements of the mining industry were considered and schemes were developed to meet the requirements of increasing production productivity. As part of these developments, special attention was paid to the standardization of equipment. Thermal imaging measures the body of an object whose temperature is above zero because it emits thermal radiation. This thermal radiation is part of the electromagnetic spectrum; its wavelength falls from 760 to 1 mm. This radiation is detected and measured by a thermal imaging device in two ways - when the thermal detector absorbs all infrared radiation (of any wavelength) and when the photon detector is exposed to radiation of only a certain wavelength. . The detector of the thermal imaging camera allows you to convert the energy of infrared radiation into an electrical signal. In individual signal processing modules, the signal is amplified, converted into digital form and converted into the temperature value of individual points of the image matrix. This is how the temperature distribution map (thermogram) of the studied object is created. A thermal imaging camera works on the principle of converting infrared radiation emitted or reflected by an object into an electrical signal, and then into an image displayed on a computer monitor. The camera consists of an optical system, infrared radiation detector, electronic amplification, processing and visualization. Belt conveyors are mechanical, hydraulic or pneumatic vehicles that operate in continuous or cyclic motion. Their purpose is to transport excavated materials, often over long distances, with different transport speeds, capacities and conveyor belts. In underground coal mines, they are the main mode of transport. Drive systems used in mining may exclude or prevent diagnostic measurements. The results obtained using various measurements can be processed in special FLIR Tools software. The works include research on the development of long-wall conveyors - they are part of the innovative development of machines and equipment. Thermal imaging is becoming increasingly popular for assessing the technical condition of belt conveyors in mines. Excavation in confined spaces creates natural hazards, mainly methane and fire. They can seriously damage machines and equipment, and even endanger human health and life. On the basis of research, the main causes of the thermal state of the drive unit were determined: slippage of the belt in the drive, problems with optimal cooling of the drive, friction of the bearings, seizure of the brake system, seizure of the drive. drums. , and the connection of pulleys. These reasons are mainly formed in the contact zone: improper cooling of the drive, contact of the drum with the belt or contact of the pulley with the belt. The main purpose of this study was to determine the thermal condition of the conveyor belt components and analyze the risk of critical temperature rise. The tests focus on the drive unit, in particular the engine, brake system and gearbox. In order to measure the actual temperature distribution occurring on the main belt conveyors, it was necessary to analyze the running time of the belt conveyors and determine the cause of any thermal anomaly. The analysis of the working time of the main freight conveyors is related to one working day in this study. The results are presented in the form of measurement images. They are developed using special programs. The properties obtained for the thermal condition are presented in the form of diagrams. This article presents a real-life example of studying the thermal state of a unit of measurement using a thermal imaging camera. All reserves identified in the mining area are

called geological reserves. According to their importance in the economy, geological reserves are divided into two groups, on-balance and off-balance reserves are considered separately. Balance reserves are suitable for industrial conditions, that is, they are economically viable for the extraction of minerals. Off-balance reserves, the amount of useful compounds in it is small, the thickness of the ore body is small, the state of their mining complex should be considered as an object that is not mined now, but can be used in the future. industry. Ore status is limited by the amount of balance and off-balance reserves. This condition applies to each individual mine or to a group of mines with similar geological and economic conditions determined by the relevant state body. The condition is, among other indicators, the minimum industrial amount of useful components in the ore, that is, the lower limit of useful compounds and economic extraction and processing of components below which the amount is ineffective (unprofitable). The measurement of the minimum industrial amount is determined individually for each mine, because it is known and the amount of money spent on the extraction and processing of ore, in turn, depends on the nature and geographical conditions of the mine. Determining the situation is a complex issue that needs to be solved together with the participation of highly qualified geologists, miners, mineralogists, metallurgists, and economists.

Materials and Methods

The application of thermal imaging in the mining industry offers a wide range of research opportunities, considering the heat production that occurs during the operation of all electrical equipment. Factors such as ambient temperature, humidity, air velocity, air volume in the excavation, and emissions have a significant impact on the measurement results. In the measurements, thermal radiation is recorded using long-wave infrared radiation. The camera captures objects, people and high temperature sources in confined or invisible conditions. Thermal imaging cameras use energy that increases as the object's temperature increases, and can capture images of any object whose temperature is above zero. The measurements result in a general temperature distribution in the background of the object, which is visible as a color change in the measurement image. The advantages of thermal imaging cameras are that they are non-invasive and can detect faults that are not normally visible to the naked eye. Testing with a thermal imaging camera is based on measuring the temperature from the outer surface, where the temperature distribution is not uniform. To obtain the appropriate quantities, an average is determined, which is the basis for detecting faults due to higher than normal temperatures. In industry, thermography is used to monitor thermal conditions in technological processes and, more precisely, to predict and prevent failures. The image taken by the thermal imaging camera reflects the temperature of the device and other inspected surfaces, which allows to assess the technical condition. Equipment such as electrical networks, main fan stations, central heating boilers and conveyor belts etc. are inspected using thermal imaging. To be considered reliable, the measurement must be made over a longer period of time and performed according to its specification, for example, the conveyor belt must be loaded with excavated material. In an underground mine, it can be very difficult to make measurements using a thermal imaging camera for this purpose.

Conclusion

One of the main factors affecting the result is the dust that prevails during the excavation process. The correct temperature range for the drive unit is affected by the length of the route, the variable load and the size of the drive drums. The main problem during the research was to obtain a suitable measuring distance. Conveyor drive components such as the motor, gearbox and brake system are recessed due to the size of the works. A fixed thermal imaging device can be used for the main conveyor devices and the data is sent to a central control room for continuous monitoring. Exceeding a predefined threshold temperature from field data can, for example, trigger an alarm. Maintenance personnel can then be dispatched to the unit to investigate the temperature anomaly and perform preventative maintenance as necessary. To minimize measurement noise, the following parameters were introduced: emissivity, humidity,

ambient temperature, and camera-to-object distance. Each of these measurements was additionally determined using a pyrometer-type device. Due to the dimensional limitations of the excavation, it was not possible to place the measuring equipment on a tripod.

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