Neo Scientific Peer Reviewed Journal
Volume 6, Jan. 2023 ISSN (E): 2949-7752
www.neojournals.com

MINING TECHNOLOGICAL EQUIPMENT THAT DETERMINES THE SLOPE ANGLES OF THE MINE BY MEANS OF LASER BEAMS

Ravshanov Zavqiddin Yahyo o‘g‘li
Tashkent State Technical University named after Islam Karimov Assistant Teacher

O‘telbayev Azizbek Alisher o‘g’li
Student of Nukus Mining Institute:

Joldasbayeva Aysulu Baxitbay qizi
Student of Nukus Mining Institute:

Bayramova Minevvar Axmet qizi
Student of Nukus Mining Institute:

Abstract:

A remote real-time monitoring system was developed for the remote real-time monitoring of mine slope deformation and internal forces. The system is based on cloud-computing technology and a 5S multimedia streaming monitoring data transmission system. It has now been applied to an open-pit iron mine in Nanfen to monitor the horizontal displacement of potential sliding surfaces. Compared with geometric monitoring methods in traditional geodetic surveying, the results show that this monitoring system has higher accuracy (0.01 mm) and the ability to monitor in real time for 24 h Slope instability of open-pit mines has adverse impacts on the overall mine profitability, safety and environment. The slope of an open-pit mine is crucially influenced by the slope geometry, quality of rock mass and presence of geological features and their properties. In open pit mines the aspect of preventing and forecasting the threat of landslides and rock falls is crucial issue because of the significant consequences that instabilities may have. Systematic slope stability monitoring is necessary to ensure safe and continuous mining operations. The development of innovative technologies, such as 3D laser scanning, opens up new possibilities, especially in the case of large and hard-to-reach areas, such as open pit mines. Terrestrial laser scanners (TLS) provide fast, efficient, detailed, and accurate three-dimensional data. The article discusses the use of 3D terrestrial laser scanning method to monitor slope displacements and landslides in open pit mines. The first part of the article discusses the risk scale of gravitational displacement on the slopes, on examples of world open pit mines, and introduces the most common slope monitoring methods. Then, the principles of 3D terrestrial laser scanning were defined, and some examples of TLS applications in the open pit mines were presented.

Open pit mines, terrestrial laser scanner, displacement monitoring, landslide, mine slope; slope monitoring; cloud computing; 5S transmission system; real-time monitoring system.

Introduction

In open-pit mining, landslides are one of the typical disasters. There are many methods for mine slope monitoring around world. For example, surface-deformation monitoring, underground-borehole inclinometer and stress monitoring, acoustic emission and microseismic monitoring, groundwater monitoring and meteorological-parameter monitoring. Geometric monitoring for slope deformation is one of the most commonly used methods. Although the geometric monitoring methods in traditional geodetic surveying have high accuracy, they require heavy workloads and a high cost, and it is difficult to arrange points and sparse measuring points. Under large-scale and complex terrain conditions, deformation measurement is greatly restricted. It is difficult to obtain enough essential displacement information for a large-scale open-pit mine. This makes it impossible to provide comprehensive and accurate information to guarantee mine slopedisaster prevention. Practical limitations may force a mine to establish interim and final slope limits and develop final walls with incomplete information. At the same time, as discussed elsewhere in this book, the potential stability of high pit slopes is difficult to predict with available investigation data and analysis techniques, particularly at the design stage. The result is a strong reliance on slope management systems, of which a comprehensive monitoring system must form an integral part. Monitoring is an invaluable tool for assessing design performance and failure risk, and for aiding risk minimisation. In today's environment, mining companies have a moral and financial obligation to eliminate the potential for accidents, and a legal obligation to protect the workforce. Legislation stipulates that employers must take every precaution practicable to provide a safe working environment. Failure to identify potential hazards and manage the associated risks could result in fines or imprisonment or both. The presence of monitoring instrumentation not only aids hazard and risk identification but reduces any workforce anxiety by confirming that ground conditions are being monitored by experienced and competent personnel. When the need for a monitoring system is correctly established and the program is properly planned, cost savings may be a direct result. However, the justification for monitoring is not primarily that of cost reduction. In some cases, the program can be valuable in proving that the design is correct and viable. In other cases, instrumentation might show that the design is inadequate, resulting in slope design modification and associated increased mining costs. In all cases, the indirect value of added safety and the avoidance of failure (and remedial costs) will make the instrumentation program costeffective. The main objectives of the slope monitoring program can be summarised as: maintaining safe operating conditions to protect personnel and equipment;

* providing advance notice of zones of potentially unstable ground so that mine plans can be modified to minimise the impact of slope displacement;
* providing geotechnical information for analysing any slope instability mechanism that develops, designing appropriate remedial action plans and conducting future slope design;
* assessing the performance of the implemented slope design. A displacement monitoring system should be established as soon as possible during the early stages of mining and

maintained throughout the operating life of the open pit. In many cases a monitoring system may be required beyond closure of the pit.
Elements of the program should be aimed at the following basic goals:
* detecting and recording any slope movement as a basis for:
# ensuring safety of the operation;
# establishing the basis for the movement (failure mode);
# managing instability;
* investigating failures and ongoing instability. Monitoring of instability assists in identifying failure mechanisms, providing crucial data for back analysis and defining appropriate remedial work;
* confirming the design model or providing a basis for assessing and modifying the designs, including specific elements:
# geology, including rock type distribution and alteration;
# structural model, with consideration of major and minor structures;
# rock properties;
# groundwater pressures;
# in situ stress levels, particularly for high slopes;
* ensuring that the slope design criteria are being achieved in terms of operating procedures.
Monitoring systems and procedures can be designed to meet these objectives. Pre-excavation instrument installation can provide important benchmark data for subsequent monitoring during mining, to validate design assumptions and modify future designs as required. In practice, such long-term instrumentation programs must withstand the ordeals associated with large-scale production mining.

Instruments

A wealth of technical literature is available on survey instruments, especially from the manufacturers. The following points are intended to highlight only the major applications of each main type to slope displacement monitoring.
^ Levels are occasionally used to determine height variations along the crests, berms or ramps of a pit. In relatively small survey areas, levelling data can provide the best height survey accuracy. The main disadvantage of levelling measurement is that human access is required to all the surveyed points. This can be difficult or impossible in the open pit mining environment.
^ Optical mechanical theodolites are now rarely used for slope monitoring, mainly due to their low efficiency and susceptibility to significant atmospheric refraction errors in observed angles.
Depending on the model, an EDM can have a range of up to several kilometres. Most instruments have two components of error: a random error plus a small percentage of the sight length. For example, the unit shown in Figure 1 has a manufacturer-quoted accuracy of 1 mm + 1 ppm. However, this depends on atmospheric conditions. To achieve high precision with EDM instruments, they must be frequently calibrated for zero and scale (frequency of modulation) corrections. The zero correction (an additive constant) given by

Neo Scientific Peer Reviewed Journal
Volume 6, Jan. 2023 ISSN (E): 2949-7752
www.neojournals.com
===

the manufacturer usually changes with time, and may also be a function of the intensity of the reflected signal. In some older EDM instruments, the zero correction may demonstrate phase-dependent cyclical changes. Each instrument should be calibrated at least twice a year, following special procedures described by the manufacturer. The calibration must account for all combinations of EDM reflector pairings, because each reflector may also have a different additive constant correction. Reflectorless EDM systems have been developed, primarily for volume measurements. While at present this type of system does not appear to have the accuracy required for slope monitoring, there is potential for such an application.

< Electronic total stations are the most commonly used survey instruments for pit slope monitoring. The instrument is designed to survey the 3D coordinates of reflective prisms located around the slope being monitored. Readings (distances and/or angles) are usually taken from a fixed instrument station on the crest of a pit to all prisms in view. The prism locations and movements are then computed from the readings. A typical total station instrument incorporating the EDM and an electronic theodolite into a single unit is shown in Figure 1.

< Servo-driven electronic total stations are increasingly popular in the mining industry for their high survey efficiency and accuracy. These can be programmed to perform preset surveying schedules with automatic detection of target prisms distributed across a pit wall. Therefore, much less human involvement is required in the field. This is a great advantage as manual observations are usually repetitive, labour-intensive and time-consuming. The system can operate continuously, if required.

The EDM instruments often include an automatic data capture and storage system. The data can be manually downloaded or automatically transmitted to a computer adjacent to the unit or by telemetry to a central server. Software is available from manufacturers or specific suppliers that can analyse the data and trigger an alarm or notify key personnel (the mine dispatcher and/or geotechnical engineer) if movement beyond a specified level is detected.

Figure 1: TCA2300 universal total station.(equipment for calculating the accuracy of the slope angle).

===

==

Laser scanning (LiDAR)

Light detection and ranging (LiDAR) technology using terrestrial laser scanning (TLS) is finding application in the mapping of the topography of pit faces and in slope monitoring. Laser scanning has similarities to radar scanning but, because of the difference in the wavelength of the signal and repeatability of measurement, is less
accurate in a reflectorless mode. However, when calibrated against known reference targets that have been located by first order surveys, a 3D image with accuracy in the centimetre range can be achieved at a range of up to 2000 m. Longer range scanners (up to 6 km) are also available, but the accuracy drops somewhat. Several survey equipment manufacturers produce laser scanning systems. A typical instrument is shown in Figure 2. Because of the lower accuracy compared to radar, laser scanning is generally not used for slope monitoring. However, it is used increasingly for defining the topography of inaccessible slopes. For example, a failure can be scanned remotely to the degree of accuracy required both to establish the size of the failure and to define the topography of the failed mass. LiDAR also has application for monitoring large waste dumps post closure, as well as natural landslides. As the technology improves and accuracy increases it is possible that laser scanning could find more extensive application in slope monitoring

Figure 2: Laser scanning unit (LPM-2K Determining the dimensions of the mining slope by laser beams)

Conclusions

Through experience, summary and theoretical analysis, database management and engineering analysis software suitable for 5S data transmission technology has been developed, and the early warning standard of slope has been determined by early warning

==

values and the change mode of the monitored quantity. Through software programming, an intelligent slope warning cloud platform and APP with convenient access and high visualization degree were developed. The system can monitor the multi-source parameters of the slope group, such as
single-point displacement, two point relative displacement, anchor bolt tension, concrete strain, rainfall, temperature and humidity, inclination and groundwater level, and can automatically issue an early warning of a potential slope disasters by SMS and email. The slope monitoring and early warning case study spanned more than two years, and verified the effectiveness of the slope remote monitoring and early warning cloud platform and app, revealing the slope horizontal displacement variation law and compared with the total station measurement results. It proved the reliability of the remote monitoring and early warning system. In conclusion, compared with other monitoring methods, the remote slope monitoring and warning system based on cloud computing can monitor potential landslides with high precision, save human resources and also realized 24 h real-time monitoring.

References
1. P. Dobak, A. Drągowski, Z. Frankowski, A. Frolik, R. Kaczyński, A. Kotyrba, J. Pinińska, S. Rybicki, H. Woźniak., Zasady dokumentowania warunków geologicznoinżynierskich dla celów likwidacji kopalń [The principles for documenting geological and engineering conditions for the purposes of mine closure], Ministerstwo Środowiska, ISBN 978-83-60117-86-6 Warszawa (2009)
2. M. Krawczyk, Stan bezpieczeństwa w odkrywkowych zakładach górniczych oraz zmiany w przepisach obowiązujących przy eksploatacji kopalin metodą odkrywkową [The state of safety in open pit mining and changes in the regulations applicable to the exploitation of mineral resources opencast method] Proc.Conf. Mining Workshop, 49-63; http://warsztatygornicze.pl/wp-content/uploads/2007_4.pdf (2007)
3. http://zzprckwb.org.pl/news/800
4. D. Milkowski, J. Nowak, Zabezpieczenie i monitoring zagrożenia osuwiskowego na filarze rzeki Nysa Łużycka oraz osuwiska "Świniec", [Protection and monitoring of landslide hazard on the Nysa Łużycka river and "Świniec" landslide], Bezpieczeństwo Pracy i Ochrona Środowiska w Górnictwie 6, 14–21 (2009)
5. D. Milkowski, A. Górecka, M. Wójcicka-Milewska, Zabezpieczenie i monitoring osuwisk powstałych na zboczu północnym wyrobiska odkrywkowego BOT KWB TURÓW SA., [Protection and monitoring of landslides formed on the northern slope of the BOT KWB TURÓW SA open pit work], Górnictwo i Geoinżynieria 32 (2) 247–256 (2008)
6. Conveyor belt structure and mode of operation in mines. Ravshanov Zavqiddin Yahyo o‘g‘li, O‘telbayev Azizbek Alisher o‘g‘li, O‘razmatov Jonibek Ikromboy o‘g‘li, Zaytova Madina Nazarbay qizi, Kulmuratova Aliya Janabay qizi. Vol. 11 (2022): EJET Дата публикации 2022/10/19, Том 11 https://www.geniusjournals.org/index.php/ejet/article/view/2360
7.Underground mine mining systems and technological parameters of mine development. Ravshanov Zavqiddin Yahyo o‘g‘li, Ergasheva Zulxumor Abdaaliyevna, O‘razmatov

Jonibek Ikromboy o‘g‘li, O‘telbayev Azizbek Alisher o‘g‘li, Djaksimuratov Karamatdin Mustapaevich. VOL. 11 NO. 10 (2022). http://www.gejournal.net/index.php/IJSSIR/article/view/1016

8. Lv, Z.Y.; Tuo, X.G.; Li, H.L.; Shi, F.R. Design on a new type of landslide wireless remote monitoring system. Met. Mine 2016, 10, 128–131. (In Chinese)

9. Xu, X.D.; Zhu, W.C.; Zhang, P.; Li, X.X.; Li, X.; Wang, H. Construction and Preliminary Application of Cloud Platform for Monitoring and Early Warning of Mining Disasters in Metal Mines. Met. Mine 2021, 4, 160–171. (In Chinese)

10. Jiang, X.X.; Li, C. Statistical analysis on coal mine accidents in China from 2013 to 2017 and discussion on the countermeasures. Coal Eng. 2019, 51, 101–105. (In Chinese)

6. Lu, N.; Dong, Y.F.; Guo, S.T.; Wu, H.; Wang, X.L.; Zhang, Y. Improvement IQR Error Detection Method of Slope Deformation Monitoring of Open-pit Mine. Met. Mine 2018, 8, 114–117. (In Chinese)