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Monitoring the backfilled slope

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Abstract: Cohesion and angle of internal are the most important contributing factors that contribute to increased slope stability are friction. The order in which the refilling must take place to ensure the stability is determined using cohesiveness and angle of friction of the soil.The main issue with overburden dumps in an opencast mining situation is slope stability.According to statistics, more than half of the accidents that occur in opencast mining are caused by equipment failure of theincorrect design of the benches, as well as insufficient work on determining geo-technical characteristics, are the causes of this slope. The safe and efficient operation of open cast mines requires the control of risks related with stability of slope. The stability issue of the slope becomes more critical during the backfilling processand more importantly when backfilling and mining process happen simultaneously.To help manage those hazards, the SSRwas developed.The Slope Stability Radar (SSR) scans rock slopes from afar and continuously monitors any surface movement.With sub-millimetre precision, it can detect and inform users of wall motions. This paper work shows an in-depth research of the elements that lead to slope stability, various slope stabilisation procedures, and laboratory-based work on calculating the overburden's geo-technical parameters. The evaluation and monitoring of slope stability is crucial in the risk management of open cut mines. In general, slope fails in open cast mines as a result of indisciplined mining and weather conditions. Slope stability radar is used to define threshold values and warns of approaching slope stability breakdown.
Keywords: opencast mine, slope stability, slope stability radar, slope monitor

1. INTRODUCTION

Soil, overburden, mine tailings, or Backfilling mines with imported aggregate material replaces excavated zones generated by mining activity. Backfilling is an important component of the system that governs the movement of ore through a mine. In the design of pit slopes, the rock slope design function frequently integrates some level of risk assessment, either expressly or indirectly. Unpredicted failures have, however, happened in the earlier days and continue to happeneven now. The slope stability radar was created in response to backfill failures (SSR). With sub-millimetre precision, continuity, and extensive coverage, the SSR system can detect and alarm wall movements.This monitoring is accomplished without the use of wall-mounted reflectors or equipment, and the radar waves are capable of passing through rain, dust, and smoke. By identifying slope movement and by givingsufficientwarning time preceding to failure, SSR improves operational risk management. To determine the slope stability a combination of field and laboratory study becomes crucial.

1.1 *Direct Shear Test of Soil*

Direct shear test is a laboratory test used to ascertain the shear strength qualities of soil or rock material. A minimum of three samples from a moderately undisturbed or remoulded soil sample are used in this test. A specimen is positioned in the shear box with two stacked rings that keep the specimen in place; the contact between the two rings is about halfway up the sample's height. The upper ring is pushed laterally until the sample fails or reaches a specific strain, and a confining tension is supplied vertically to the specimen. To determine a stress–strain relationship, the load applied and the strain

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caused are recorded at regular intervals.To measure the shear strength parameters, soil cohesion, and the angle of internal friction generally known as friction angle, several specimens are examined at varied confining loads. The peak (or residual) stress on the y-axis and the confining stress on the x-axis are plotted on a graph for each specimen's results. The cohesion is the y-intercept of the curve that fits the test data, and the friction angle is the slope of the line or curve.

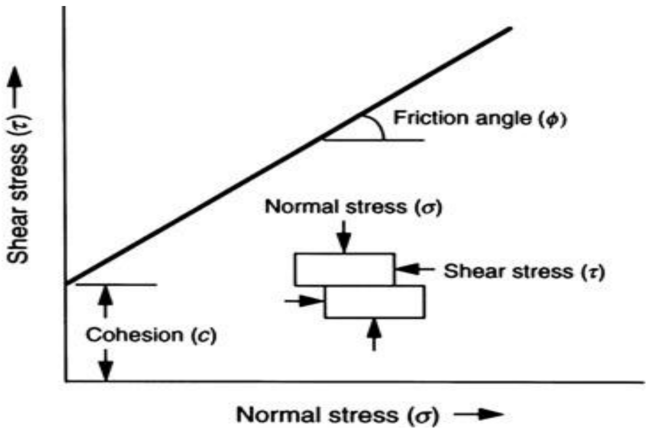

Fig:1 Shear stress vs Normal stressgraph

Fig:2 Direct shear apparatussetup

1.2 An operational perspective of mine backfill

Mine backfill has a major impact on mining operations' economics by impacting the total reserve of high-value ore and the rate at which this high-value ore can be recovered with minimal dilution within a given footprint of developed ore body. When considering the cost-benefit trade-offs of various backfilling procedures, this might be a complicated economic issue.The choice to raise development expenditures and open up a bigger mine footprint in order to reach higher value ore Early in the mine's life, when high-cost backfill is less of a factor, can have an impact on the economics of larger operation . Backfilling costs can be significant, accounting for up to 30% of total mining costs, As a result, it's vital to understand cost drivers so that backfill performance isn't jeopardised throughout any cost-cutting effort.

1.3 General guidelines of backfilling

When segregation is a concern, the following generalised practises are recommended:

Maintain a particle size of less than 75 mm at all times. Particles with a diameter higher than 75 mm are more likely to segregate. Fill the bench with both wet and dry fills from the same area. Placing constituent elements in various positions on the bench is the simplest technique to produce segregation. Make that the wet and dry fill components' trajectories are coordinated when entering the benches. Vertical trajectories are the easiest to regulate and ensure the best chance of good surface mixing. Minimize the amount of free water at the surface of the backfill when filling benches with hydraulic fill, as this tends to create layers of differential permeability (as ultrafine particles are filtered out of the surface water as it drains through the fill surface).

1.4 Slope monitoring system

Foreseeing oncoming instabilities and consequent rock failure, slope monitoring systems with highly sophisticated radars and global navigation satellite systems are used. In opencast situations, traditional

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procedures such as manual inspection and enhanced microseismic monitoring are also used.

1.4.1 Slope Stability Radar system

For both coal and non-coal mines, slope stability is a key safety and productivity concern. Monitoring minor precursory movements that occur prior to collapse is a frequent technique for determining slope stability.

1. Safety Critical Monitoring

2. Campaign Monitoring

1.5 Types of alarm

Red Alarm

It is employed as a critical alert condition in which an emergency situation is declared, and the pit superintendent is contacted to evacuate the affected area a swell as calling the geotechnical department.

Orange Alarm

It's also known as a "geotechnical alarm," and it occurs when movements suggest a developing scenario that the geotechnical department should be aware of in order to provide direction.

Yellow Alarm

It's a sign of a radar system failure, with the pit superintendent being told that the radar is down and the geotechnical department being notified to assess the SSR.

Green Alarm

The SSR is shut down and the SSR viewer programme is restarted as per procedure, indicating a minor system failure.

Measurement of water level and pressure

Drilling and casing a borehole is the most common way of monitoring the water table in a slope. Dropping a measuring tape down the boring locates the water surface.

1.6 Standpipe Piezometer

These piezometers are used in observational wells to monitor piezometric water levels. A filter tip is connected to a riser pipe in a standpipe piezometer. Polyethylene or a porous stone with a pore size of 60 microns is used to create the filter tip. After the filter tip, riser pipe is inserted downhole. Around the filter tip, a sand filter zone is put in place. To isolate the bore water at the tip, the top of the filter zone is sealed with bentonite. To prevent vertical water migration, bentonite grout is used to backfill the annular region between the riser pipe and the borehole. A vented cap is used to finish the riser pipe above ground level. A water level indicator is used to measure the water level in the standpipe piezometer or the observation well.

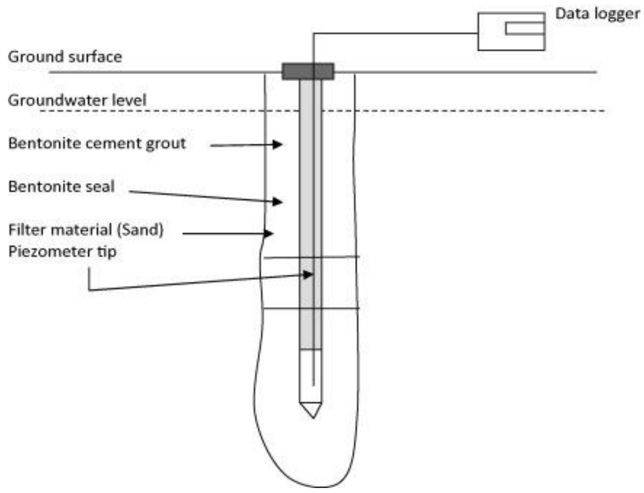

Fig: 3 Stand/pipe Piezometer

Water Level Monitoring

Months	W-10	W-22	W-13	W-14	W-15	W-16	W-23
Jan-20	2.30	2.40	2.30	3.00	3.90	3.10	3.50
Feb-20	2.50	2.70	2.70	3.90	4.30	3.40	4.10
Mar-20	3.40	3.90	3.30	4.70	6.10	6.20	5.80
Apr-20	4.30	4.30	3.90	5.10	5.30	8.10	6.00
May-20	4.70	5.10	4.80	5.90	5.90	8.70	5.20

Table 1

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1.7 Hardware Requirements

The scanning antenna and the radar electronics box are connected through an umbilical cable in a typical arrangement. The scanning antenna is made out of a 0.92m diameter parabolic dish mounted on a strong tripod and moved up and down by independent motors and gears. The slope stability radar has a maximum range of 500 metres to ensure that adequate reflected signal from the rock slope is received. A digital camera image is used to set the scan region, which can scan 320 degrees horizontally and 120 degrees vertically.Two versions of SSR data are frequently presented. To begin, a colour rainbow with a slope that represents whole movement. Second, to examine displacement rates, time/displacement graphs can be picked at any position.

Fig. 4 SSR deployment likes weather antenna, Wi-Fi modem, scanning disc, Wi-Fi antenna, monitoring room (Geo information monitor), Virtual portal network,and worldwide open source handler

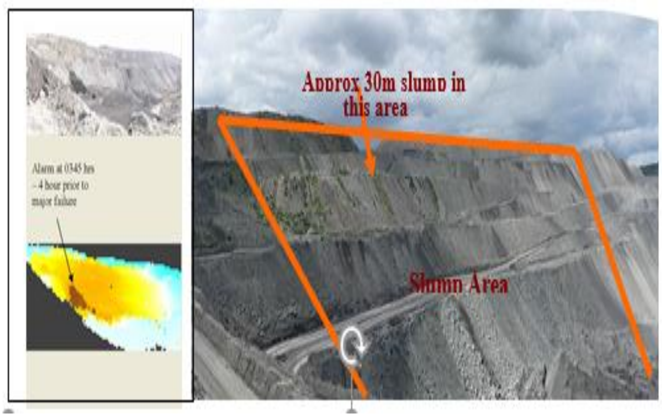
1.8 SSR-Viewer

SSR-Viewer software allows for quick and precise data analysis to spot trends, as well as the ability to generate warnings for prompt action. Users of our programme may see what has moved, when it has moved, and predict when it will fail by processing the data that our hardware collects.

Ground Probe has released SSR-Viewer 9, a simple upgrade to its SSR-Viewer software platform, which was developed over the last 17 years with knowledge gained from the world's largest database as a result of slope collapses.

Fig:5 Deformation and Rainbow pattern by SSR VIEWER

The SSR-Viewer software package is used by all of Ground Probe's Slope Stability Radar products. It analyses the data collected by our radars, allowing our clients to make critical decisions in real time that affect company revenue and employee safety.



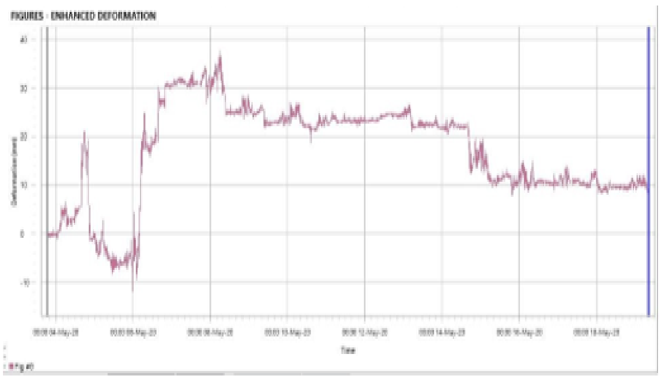


Fig: 6 Deformation graph

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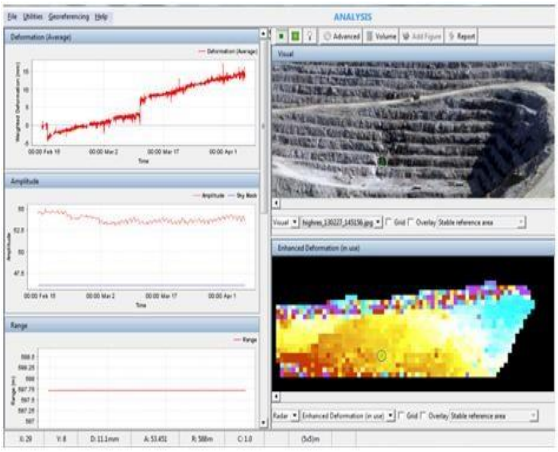

Fig:7 Result obtain from the software

II CONCLUSION AND RECOMMENDATIONS FOR MONITORING

The SSR is also expected to make a substantial contribution to mine safety and design by providing accurate, dependable deformation data that can be used to improve our understanding and analysis of failure causes in mines with open pits. Deploy slope stability radar with integrated visual imaging system or any similar technology that provides real-time monitoring of slope, strata, or dump displacements well in advance of any failure, giving mine management enough time to safely withdraw men and machinery from such prone areas, according to DGMS Circular No.02 Dhanbad, dated 06.07.2010. Not only would this technology increase the safety of opencast operations, but it would also increase their productivity and efficiency.

REFERENCES

1) Santosh Kumar Behera,2016.The Central Institute of Mining and Fuel Research designed an embankment for safe backfilling of opencast mines.. Department of mine stowing and filling.

2) Vinoth Srinivasan,2020.status and development of slope monitering techniques in opencast mines, National Institute of Technology,karnataka.

3) Arvind Kumar Mishra, 2016. status and development of slope monitoring techniques in opencast mines, Indian Institute of Technology (ISM), Dhanbad. Department of mining engineering.

4) B.A. Reeves, G.F.Stickley. "Radar interferometry is being used to check mine slope stability."

5) Dr.Neal Harries, Dr David Noon, Mr Keith Rowley. "case studies of slope stability radar used in open cut mines".

6) Dick,G.J, "Development of an early-warning time-of-failure analysis methodology for open-pit mine slopes utilizing ground-based slope stability radar monitoring data".

7) Sumit Kumar. "Constructing Structures on Backfilled Opencast Mine Spoil for Better Sustainability".May 2018

8) Jixiong Zhang, Meng Li."Properties and Application of Backfill Materials in Coal Mines in China".June 2019