v. 2, n. 6, 2022

Journal of
Engineering
Research

TECHNICAL EVALUATION OF ROCK MASS INSTABILITY DEVELOPED AT THE INSTITUTO TECNOLÓGICO SUPERIOR DE FRESNILLO

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Abstract: This methodology is a study strategy on the factors that influence the instability of a rock mass, considering the methods for classification RQD (Rock Quality Designation) the RMR (Rock Mass Rating) Q (quality index) is the sum of the RQD . It should be noted that it is extremely important to verify these, given that they give rise to accidents and work stoppage due to the presence of instability in massifs, it is also intended to verify the best applicable methods for this problem in order to have a safe work environment where both companies and workers benefit, companies having the peace of mind that the risk of accidents caused by instability is reduced and workers can work with the confidence that the risk of an accident due to said problem is minimal. The possible results when the proposal is implemented is the reduction of the problems caused by the instability of the rock, another of the possible results will be an improvement of the methods already applied, that is, those already used will be implemented but in a shorter period of time. . It was developed at the Institute.
Keywords: Factors, instability, rock mass, methods, accidents.

INTRODUCTION

In order to prevent the aforementioned problems from occurring, it will also be necessary to carry out surveys to obtain rock cores and be able to analyze them to see what quality they are in. These in order to determine which are the best methods that can be applied to solve the instability problem.

METHOD DESCRIPTION

The methodological proposal focuses on conducting a study of the factors that influence the instability of a rock mass, the present investigation will be based on three processes, which will be:

1.- Determine the factors that influence the poor quality of the massif, such as geomechanical factors, lithological factors, factors related to efforts and construction processes.

2.- Carry out a survey, which consists of the subtraction of a rock witness which is subtracted to be later analyzed in order to know the conditions in which it is found. Determine the quality of the rock using established methods such as: RQD (Rock Quality Designation) RMR (Rock Mass Rating) Q (quality index).

3.- Determine the best method for the stability of the massif.

Methods used Unsupported, Spot bolting, Systematic bolting, Unreinforced shotcrete: Fidre reinforceb shotcrete, Bolt, Bolting. Reinforced ribs, Shotcrete, Cast concrete lining factors A factor is an element that influences something. In this way, the factors are the different aspects that intervene, determine or influence so that a thing is in a specific way. (MX, 2014).

Rock massA rock mass is a discontinuous, anisotropic and heterogeneous medium formed as a whole by both blocks of rock matrix and different types of discontinuities that affect the rock medium, mechanically rock masses can be considered to have zero tensile strength.(Geologiaweb, Rock mass, rock matrix and discontinuities. Description and characterization of rock masses, nd) accidentsThe concept refers to something that happens or arises unexpectedly, since it is not part of whatnaturalor the essence of the thing in question.(Gardey, 2012).

Factors that influence the instability of a rock mass

The rock fall constitutes one of the greatest risks in underground mining. For this reason, for safe mining operations, it is essential that mine personnel identify rock mass instability issues, which can lead to potential rock mass

failure. In this way, adequate measures can be taken to prevent accidents caused by falling rocks.

Before carrying out an excavation, the rock mass is in equilibrium. However, when the excavation has been created, it breaks the pre-existing equilibrium conditions. The aforementioned creates disturbances in the rock mass that must be controlled. When these disturbances are adverse, they can result in rock mass instabilities such as fracturing and rock loosening. It also creates slippage across discontinuity surfaces, excessive roof deflections, convergence or closure of excavation contours or vein work pockets, spalling, flaking, bursting, and rock bursting.

The identification of rock mass instabilities must be carried out continuously during the development of the mine. In this sense, it must be carried out based on the geomechanical information that is available and the routine inspections of the rock mass of the mining openings.(Mining, 2017).

GEOMECHANICAL FACTORS THAT AFFECT THE STABILITY OF THE MASSIF

The factors considered in the geomechanical classifications and that influence the global behavior of a rock mass are: fracturing, the conditions of the discontinuities and the presence of water. In this way, a highly fractured massif will tend to be less resistant than a massive one; a massif in which the discontinuities are rough will be stronger than one in which they are smooth; the characteristics of the filling of the discontinuities will be a very important conditioning factor in the overall response of the massif (no filling, clay filling, calcite filling or other crystals, the hardness and deformability of these fillings, their degree of alteration, etc.); the conditions of tightness, humidity or flow and water pressure will largely determine the resistance.(Mining, 2017).

LITHOLOGICAL FACTORS THAT AFFECT THE STABILITY OF THE MASSIF

A healthy and good quality massif may be formed by a matrix rock that is not very resistant or, on the contrary, a massif of very poor quality and therefore not very resistant (very fractured and altered), it may be formed by a very hard matrix rock. The factors that determine the resistance of the matrix rock can be: the mineralogical composition, the size of the crystals or grains, their homogeneity or heterogeneity, the porosity. In this way, a healthy massif of high geotechnical quality, formed by a detrital matrix rock such as marl, may have less resistance than a highly fractured rhyolitic massif of low geotechnical quality. (Technicians, Geotechnical integration and preliminary design, 2016).

FACTORS RELATED TO EFFORTS AND CONSTRUCTION PROCESSES

The stress states and the way in which a work disturbs them can significantly condition the global response of a rock mass. Thus, tectonic history or depth can cause stress states to be (or not) close to failure; The magnitude of the friction behavior will depend on the level of confinement at which the work is found; the initial stress distribution can induce unfavorable trajectories and rotations for the behavior of an excavation; the type of disturbance will induce different types of behavior, that is, if it is about excavations (unloading processes) or constructions (loading processes). Additionally, the level of damage produced to the massif by the excavation processes, especially when explosives are used,(Technicians,

Geotechnical Integration and Preliminary Design, 2016).

REALIZATION OF GEOTECHNICAL SURVEYS

Drilling is understood as a small-diameter perforation that allows recognizing the nature and location of the different layers of the ground, as well as extracting samples from it and carrying out "in situ" tests. Special emphasis should be placed on the fact that the object of the geotechnical survey is the testification of the terrain, at depths beyond those that are feasible for means of direct observation consisting of the reliable verification of the lithology and characteristics of the material, such that it allows its unequivocal identification. . Likewise, the geotechnical survey has as its mission the taking of adequate quality samples for analysis in the laboratory, and the execution of "in situ" tests that allow the evaluation of the geotechnical parameters of the terrain, especially in those cases in which the taking of undisturbed samples is almost unfeasible. (Franky, 2016).

When carrying out the surveys, rock cores will be obtained which will be taken to the laboratory where they will be evaluated and with this the quality in which they are found will be determined by means of the following already established standards.

RMR:(Rating of the Rocky Massif) The system consists of a methodology for the classification of rocky massifs that allows to relate quality indices with geotechnical parameters of the rocky massif, excavation and support criteria. (Bieniawski geomechanical classification or RMR classification developed in 1973, updated in 1979 and 1989).

The RMR classification takes into account the following geomechanical parameters:

- The uniaxial strength of the rock matrix.
- The degree of fracturing in RQD parameters.
- The spacing of discontinuities (planes of weakness).
- The conditions of the discontinuities.
- Hydrogeological parameters or conditions.
- The orientation of the discontinuities with respect to the excavation structure.

RMR geomechanical classification (Bieniawski, 1989).

The RMR gemechanical classification (Bieniawski, 1989), aims to define the quality of rock masses based on the RMR index, this index is calculated taking into account the resistance of the rock matrix, the RQD index, condition of the discontinuities and parameters hydrogeological.

The RMR index distinguishes five classes that correspond to the quality of rock masses,

Clase	Calidad	Valoración RMR	Cohesión	Ángulo de rozamiento
I	Muy buena	100-81	> 4 kg/cm2	>45°
II	Buena	80-61	3-4 kg/cm2	35°-45°
III	Media	60-41	2-3 kg/cm2	25°-35°
IV	Mala	40-21	1-2 kg/cm2	15°-25°
V	Muy mala	<20	1 kg/cm2	<15°

RQD :(Rock Quality Designation).

Rock Quality Designation Table and its RQD.

Calidad de la roca	Calificación	RQD (%)
Muy mala (roca completamente meteorizada)	I	<25%
Mala (roca meteorizada)	II	25 a 50%
Media (Roca levemente meteorizada)	III	51 a 75%
Buena (Roca dura)	IV	76 a 90%
Muy buena (Roca fresca o intacta)	V	91 a 100%

Q:Rock quality.

related to geotechnical characteristics that are taken into account for the application of civil engineering and mining works, especially tunnels or slopes.(Geologiaweb, RMR geomechanical classification (Bieniawski), parameters and tables, sf).

It is used to define initial quality parameters of a rock mass where it is planned to carry out some type of construction.Rock Quality Designation (RQD) is a measure of the quality of the core or core rock taken from a borehole. RQD means the degree of joint or fracture in a rock mass measured in percent, where RQD of 75% or more indicates good quality hard rock and less than 50% indicates poor quality weathered rock samples.

This field test provides an assessment of rock strength and weather damage.

The RQD must be recorded on site when the core is retrieved because some rocks may disintegrate, due to desiccation, stress relief, or swelling, over time; For these rocks it is recommended that the RQD be measured again after 24 hours.

The measurement of the RQD is done in each drilling maneuver or in the lithology variation, it is recommended that the maneuver length does not exceed 1.5 m, in addition, the minimum diameter of the cores must be 48 mm.

The measurement of the length of the piece of the core is made on the central axis and the fragments that have a full diameter are considered.(Geologiaweb, RQD, Rock Quality Designation, nd).

Rock mass classification system that allows estimating geotechnical parameters of the mass and design supports for tunnels and underground caverns. (Barton, Lien and Lunde in 1974)(Sources, 2017).

It is calculated using 6 geotechnical parameters according to the following expression:

$$\mathbf{Q = (RQD/Jn)\ (Jr/Ja)\ (Jw/SRF)}$$

PARAMETERS

The Q Barton classification is given by the following equation:

Parameter 1 (RQD)

Parameter 2 (joint index Jn)

Parameter 3 (Jr Roughness Index)

Parameter 4 (Presence of water Jw)

Parameter 5 (alteration of discontinuities Ja)

Parameter 6 (SRF)

Methods for the stability of the massif.

Concrete reinforcement categories: categories of concrete reinforcement.

1. Unsupported: Does not need support.
2. Spot bolting: Anchors.
3. Systematic bolting: Anchor system.
4. Unreinforced shotcrete: Non-reinforced concrete.
5. Fidre reinforceb shotcrete: Concrete or concrete reinforced with fiber.
6. Bolt: Anchor.
7. Bolting: Anchor.
8. Reinforced ribs: Reinforced ribs.
9. Shotcrete: Shotcrete.
10. Cast concrete lining: Fortification and anchoring.

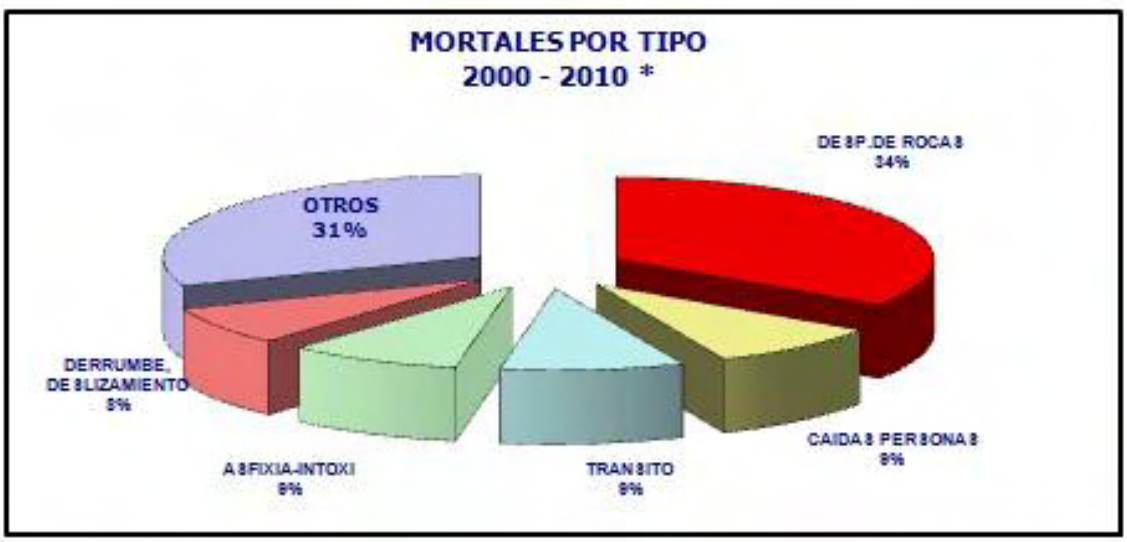
Regarding the methods used for the stability of massifs, the key for these to work effectively to avoid accidents is that they are used appropriately, that is, the necessary evaluations must be carried out to know which is the best applicable method, as well as taking take into account other things such as the length to which support is intended. The same happens with your installation, which must be efficiently controlled to comply with the procedures correctly. This will allow you to get the maximum performance from the system.

RESULTS

As a result, it is intended that the company carry out evaluations of the rock mass more frequently, making logs where the activities that have been carried out or are intended to be carried out, such as blasting, excavations or advances, which affect its stability, are reflected. They must carry out studies on the massif in order to be able to implement the appropriate methods for their stabilization and thereby be able to reduce accidents caused by rockfalls.

RECOMMENDATIONS

It is important to carry out surveys periodically, because it turns out to be very dangerous to work in places where there is instability of the massif and there may be a rock fall, 34% of fatal accidents are caused by said action.



That is why the recommendations that are proposed are:

Carry out preventive and/or corrective measures in order to reduce accidents caused by rock instability.

- The support standards indicated in the geomechanical plan must be complied with, hazards must be permanently identified and the risks of rock instability must be evaluated.
- Comply with the technical design parameters in the execution of the mining work.
- Carry out fortifications and anchorages where necessary depending on the data produced by the studies carried out.

CONCLUSIONS

After the development of this investigation we can conclude that the stability of the rock mass depends on several factors, this also depends on the period in which the relevant evaluations are carried out to determine what condition it is in, the certainty of the results obtained depends in a great way of the criterion of the moment of making the data collection depending on the factors used and the quality of the rock, the categories of concrete reinforcement are implemented. Finally, a methodology is intended with the objective of analyzing problems anticipating the behavior of the rock mass from the planning stage.

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