Vol. 13, No. 34, Spring 2023, pages 15-26

Journal of Analytical and Numerical Methods in Mining Engineering

Journal home page: http://anm.yazd.ac.ir/

Research article

Determination of Hoek and Brown damage factor due to explosion around tunnels using numerical modeling

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*(*Received*: May 2022*, Accepted*: August 2022)*

Keywords

Tunnel blasting
Hook-Brown failure criterion
Damage factor
Finite element method
LS-DYNA software

English Extended Abstract

Summary

In this study, the effect of the damage factor was studied by LS-DYNA as a three-dimensional finite element modeling in a tunnel. The results showed that the blasting pattern will have a significant effect on the intensity of damage so that the Hoek-Brown damage factor (D) increases with the number of blasting holes in a delay and significantly decreases with decreasing of hole diameter. The results also indicated that by increasing the depth of the tunnel, D will decrease.

Introduction

Despite the economic benefits of using explosives, the damage caused by rock blasting changes the mechanical properties of rock masses and causes unavoidable problems. Therefore, it is necessary to determine the damage caused by blasting the rock around the tunnels. Several important types of research have been done on the design parameters of blasting on rock damage and evaluated the extent of blast damage using the maximum particle velocity method or numerical simulations to study the response of underground structures exposed to the blasting. In this study, due to the efficiency of the LS_DYNA software in simulating problems with the high strain rate and solver speed in three-dimensional problems used.

Methodology and Approaches

In this study, a tunnel under blasting loads based on finite element methods was modeled and the influence of characteristics such as tunnel depth, number, and diameter of blasting holes were investigated on D. Modeling was conducted by LS-DYNA hydro code. Here, the optional Eulerian-Lagrangian (ALE) and Lagrangian solution algorithms are used for blast materials and rock materials, respectively. To simulate the rock, due to the absence of Hoek-Brown failure criteria, the Mohr-Columb behavioral model was used.

Results and Conclusions

In this research, an attempt was made to study the effect of damage factor (D) in a tunnel with a diameter of 5 m, and the borehole pressure due to the blasting was simulated based on the JWL equation in the LS-DYNA hydro code. In this regard, the effect of various parameters such as tunnel depth, number, and diameter of blasting holes on the Hoek-Brown disturbance factor was investigated. The results showed that D increases with increasing the number of blasting holes because the dynamic wave created by the blasting load increases. For example, by increasing the number of holes from 26 to 36 holes that will explode simultaneously in a delay damage zone will increase from about 4 meters to 7.5 meters. As the diameter of the blast holes increases the severe damage zone will increase. Therefore, for wall holes, it is necessary to reduce the diameter of the hole and the weight of the explosive charge as much as possible. As the depth of the tunnel increases, D will decrease. If the pressure of the surrounding rock is reduced from 0 to 30 MPa, the thickness of the severe damage zone will be reduced from 4 m to 1 m.

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DOI: 10.22034/ANM.2022.2738