

ABSTRAK

ANALISIS STABILITAS LUBANG BUKAAN TERHADAP PENGARUH BIDANG DISKONTINUITAS PADA PENAMBANGAN MANGAN BAWAH TANAH

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Penambangan mangan bawah tanah di Desa Karangsari, Kecamatan Pengasih, Kabupaten Kulon Progo dilakukan dengan sistem lubang bukaan berupa adit pada batuan gamping yang memiliki banyak bidang diskontinuitas. Keberadaan bidang diskontinuitas seperti kekar menyebabkan massa batuan menjadi lebih lemah dan berpotensi mengalami keruntuhan, sehingga diperlukan analisis kestabilan lubang bukaan. Penelitian ini bertujuan untuk menganalisis pengaruh orientasi dan spasi bidang diskontinuitas terhadap tingkat kestabilan lubang bukaan pada penambangan mangan bawah tanah.

Metode penelitian dilakukan melalui observasi lapangan untuk karakterisasi massa batuan dan pengukuran bidang diskontinuitas, serta pengujian laboratorium untuk memperoleh sifat fisik dan mekanik batuan. Analisis kestabilan dilakukan dengan pendekatan empiris menggunakan *Rock Mass Rating (RMR)* dan *Geological Strength Index (GSI)*, serta pendekatan analitik dengan kriteria keruntuhan Hoek–Brown. Selain itu, dilakukan pemodelan numerik menggunakan metode elemen hingga (FEM) dengan asumsi *plane strain* untuk mengevaluasi nilai *Strength Factor (SF)*, distribusi tegangan, dan deformasi pada berbagai variasi orientasi (*dip*) dan spasi bidang diskontinuitas.

Hasil penelitian menunjukkan bahwa orientasi dan spasi bidang diskontinuitas berpengaruh terhadap nilai *Strength Factor*. Semakin besar sudut kemiringan bidang diskontinuitas dan semakin rapat spasinya, maka nilai *Strength Factor* cenderung menurun. Namun demikian, berdasarkan pemodelan nilai *strength factor* pada lokasi penelitian menunjukkan nilai $SF > 1$ dimana kondisi lubang bukaan yang terdapat bidang diskontinuitas masih aman dan stabil. Hasil ini dapat digunakan sebagai dasar pertimbangan teknis dalam perencanaan penambangan bawah tanah yang aman.

Kata kunci: bidang diskontinuitas, kestabilan lubang bukaan, dan *strength factor*

ABSTRACT

Analysis of Underground Opening Stability Due to the Influence of Discontinuities in Underground Manganese Mining

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Underground manganese mining in Karang Sari Village, Pengasih District, Kulon Progo Regency is carried out using an adit opening system in limestone rock that contains numerous discontinuities. The presence of discontinuities such as joints reduces the strength of the rock mass and increases the potential for failure; therefore, stability analysis of the excavation is required. This study aims to analyze the influence of discontinuity orientation and spacing on the stability level of underground mine openings.

The research methods include field observations for rock mass characterization and discontinuity measurements, as well as laboratory testing to obtain the physical and mechanical properties of the rock. Stability analysis was conducted using empirical approaches, namely Rock Mass Rating (RMR) and Geological Strength Index (GSI), and an analytical approach based on the Hoek–Brown failure criterion. In addition, numerical modeling using the Finite Element Method (FEM) with a plane strain assumption was carried out to evaluate the Strength Factor (SF), stress distribution, and deformation under various discontinuity orientation (dip) and spacing conditions.

The results indicate that discontinuity orientation and spacing significantly influence the Strength Factor values. Increasing the dip angle and decreasing the spacing of discontinuities tend to reduce the Strength Factor. However, based on the modeling results, the Strength Factor values at the study site are generally greater than 1 ($SF > 1$), indicating that the underground openings with discontinuities remain stable and safe. These findings can be used as a technical reference for safe underground mining design and planning.

Keywords: discontinuities, underground opening stability, and strength factor