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NUMERICAL JUSTIFICATION OF MINE WORKING STABILITY BASED ON REGULATORY APPROACHES USING MIDAS GTS NX

The development of the Kryvyi Rih Iron Ore Basin is carried out under complex mining and geological conditions, including significant working depths, rock mass fracturing, heterogeneity, and the presence of tectonic faults. In such conditions, ensuring the stability of underground excavations requires the integration of numerical modeling and regulatory frameworks of Ukraine and the European Union.

According to DSTU-N B V.2.1-10:2009, DBN B.1.2-2:2006, DBN B.2.1-10:2009, and Eurocode 7 (EN 1997-1:2024), the stability assessment of geotechnical systems should be performed using the limit state method, considering partial safety factors and possible deformation development scenarios.

In international practice, numerical modeling software widely used includes MIDAS GTS NX, PLAXIS, and FLAC3D:

PLAXIS — effective for 2D and axisymmetric soil mechanics problems.

FLAC3D — suitable for modeling large deformations and nonlinear processes in rock and soil masses.

MIDAS GTS NX — allows modeling the three-dimensional stress-strain state of rock masses, physical nonlinearity, staged excavation/construction, and integration of engineering support elements, making it versatile for complex mining tasks.

Key strength criteria:

Mohr–Coulomb criterion: $\tau = c + \sigma \cdot tan(\varphi)$

Hoek–Brown criterion: $\sigma_1 = \sigma_3 + \sigma_{ci} \left(m_b \frac{\sigma_3}{\sigma_{ci}} + s\right)^a$

Factor of safety: $F_s = \frac{R}{S}, \; F_s > 1$

where (c) — cohesion, (φ) — internal friction angle, (σ_1, σ_3) — principal stresses, (σ_{ci}) — intact rock strength, (R) — ultimate strength of the mass, (S) — applied load.

Global experience with MIDAS GTS NX:

Design of transportation tunnels and metro systems (Asia, Europe).

Stability analysis of open-pit mine slopes.

Modeling of underground structures and storage facilities.

Assessment of construction impacts on urban areas.

Practical application for the Kryvyi Rih region:

Justification of chamber and pillar parameters considering mining depth.

Determination of safe pit and bench slope angles.

Prediction of plastic deformation zones and potential collapses.

Optimization of support systems and mining schemes.

Assessment of anthropogenic impact on the surface.

Conclusion: Numerical modeling using MIDAS GTS NX is an essential stage in the design and supervision of mining operations in the Kryvyi Rih region. It improves calculation accuracy, enhances safety, and ensures long-term stability of mine workings.

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