Annualized Probabilities of Pit Slope Failures for Quantitative Risk Analysis

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Introduction

In the realm of open pit mining, assessing the risks associated with pit slope failures is paramount for ensuring safety and optimizing economic returns. This paper delves into the amalgamation of various methodologies for quantitative risk assessment in open pit mining aimed at providing clients with robust risk evaluation tools coupled with economic analyses of their pit designs.

History and Context

Having worked with open pit mines and rock slopes for over two decades, our team has witnessed the evolution of risk assessment methodologies. From probabilistic geomechanical models to event trees and, more recently, the adoption of advanced computational techniques like ORE2_Slopes, our journey has been one of continuous refinement and innovation.

Estimation of the Annual POF from the Geomechanical POF

Traditional geomechanical models offer valuable insights into the probability of slope failures. However, these models lack a temporal aspect making them inadequate for annual risk assessments. To address this gap, Contreras (2024) proposes a methodology to annualize geomechanical probabilities of failure (POF), thereby bridging the gap between static assessments and dynamic risk evaluations.

ORE2_Slopes Based Open Pit QRAs

ORE2_Slopes is a powerful tool for open pit quantitative risk assessments (QRAs). Leveraging diagnostic points and advanced computational algorithms, ORE2_Slopes facilitates a holistic evaluation of potential failure scenarios, incorporating typical and atypical conditions. The results of QRAs conducted using ORE2_Slopes offer valuable insights into the stability and resilience of open pit designs.

Literature Data and Benchmark Comparisons

Benchmarking against industry standards and literature data provides crucial validation for risk assessment methodologies. By comparing QRAs results against established benchmarks, such as those proposed by Riskope now a business unit of SRK, our analysis gains further credibility and relevance in the context of real-world scenarios.

Comparison Between the Approaches

A comparative analysis between geomechanical approaches and ORE2_Slopes highlights the strengths and limitations of each methodology. By examining the convergence of results and identifying key differentiators, stakeholders can make informed decisions regarding risk mitigation strategies and design optimizations.

Conclusions

In conclusion, our collaborative effort endeavors to provide a unified framework for open pit risk assessment, balancing technical rigor with practical applicability. By embracing advancements in computational modeling and integrating economic evaluations, we aim to empower clients with actionable insights for optimizing pit designs and ensuring operational resilience.

Key Lessons Learned:

1. Shift to Annualized Values: Recognize the significance of estimating annualized PoFs for QRA.
2. Holistic Approach: Consider the impact of various parameters such as time dependency, human factors, monitoring, and maintenance for a comprehensive risk assessment.
3. Validation through Real-Life Experiences: Compare probabilistic estimates with real-life pit experiences and literature benchmarks to ensure practical applicability and anchoring to reality.

4. Adaptability: Continually refine and adapt methodologies to enhance reliability and provide clients with informed tools for decision-making.

This approach aims to provide a unified framework, balancing geomechanical considerations with economic assessments. The focus on key lessons learned reinforces the practicality and reliability of the proposed methodology for open pit designs.