Analysing the Haul Road Design From the Simulation Perspective: Theoretical and Real Improvements

R L Peroni1, J L V Mariz2, E G Neto3, D J 4 Souza and A Moradi4

1. Professor, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, 91509-900. Email:peroni@ufrgs.br

2.Post-doctorate, Mineral Research and Mine Planning Laboratory, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil Email: jorge\_valenca@hotmail.com

3.Mining Engineer, Mineral Research and Mine Planning Laboratory, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil. Email: eduardo\_goneto@hotmail.com

4. Mining Engineer, Mineral Research and Mine Planning Laboratory, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil. Email: dayssouza11@gmail.com

5. Assistant Professor, Sustainable Intelligent Mining Laboratory, University of Kentucky, Lexington, KY 40508, USA. Email: ali.moradi@uky.edu

Keywords: Haul road design, equipment performance, discrete-event simulation,

# ABSTRACT

In mining operations where trucks are the primary means of moving ore to processing plants and waste to dump sites, the efficiency of the production flow system is heavily influenced by the quality of haul roads. A thorough understanding of the requirements for constructing durable haul roads and predicting their behavior, including deterioration patterns and maintenance frequency over their lifespan, is essential. Haul road quality directly impacts the performance of the transportation system, which can account for 45-55% of mining costs. While equipment performance charts from suppliers offer insights into key indicators, such as truck speed, cycle time, and fuel consumption, these often assume deterministic conditions with a constant road quality. However, challenges arise when road design varies along its length or when poor design, inadequate drainage, and accelerated deterioration disrupt initial performance assumptions. Additionally, most mines feature road networks shared by multiple equipment types, including production and maintenance vehicles and light-duty traffic, leading to frequent interferences. This study uses discrete-event simulation to model these complexities, providing a realistic view of fleet performance under varying conditions. By comparing scenarios with and without best practices in haul road construction, we demonstrate the advantages of well-maintained roads and quantify the impact of road deterioration on equipment performance over time. This approach highlights the importance of maintaining steady road quality to achieve optimal transportation system efficiency, underscoring the benefits of sound haul road practices in minimizing costs and maximizing operational stability.