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Application of recent fracture mechanics criteria to notched rock fracture analyses

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(SENER INGENIERÍA Y SISTEMAS - Spain)

Differentiating cratering mechanisms in rock blasting based on geomechanical characterization

Dr. Jonathan Aubertin

(Université du Québec, École de Technologie Supérieure - Canada)

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Alida Hartzenberg (South Africa)

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Mr. Jean Pierre Gouvea (South Africa)

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Application of recent fracture mechanics criteria to notched rock fracture analyses

Abstract

Quasi-brittle materials like rocks display very limited non-linear behaviour before failure and, therefore, crack propagation is unstable and leads to sudden fast fracture. This condition can result in catastrophic failures of rock masses and structures, especially under the presence of defects which act as stress concentrators. The considered defect type has a strong influence on the generated stress fields. For this reason, efficient criteria to perform accurate rock fracture assessments under the presence of defects is a major issue of interest in many practical rock engineering applications. This presentation will focus on two recent fracture mechanics criteria to perform fracture analyses of notched (defects with significant radii) rock components. In particular, the applicability of the Theory of Critical Distances (TCD) and the Strain Energy Density (SED) criterion in the field of rock mechanics is studied. The former method consists of a local fracture criterion based on the stress field around the defect tip, and the latter is an energy-based approach. The experimental comparison of fracture results under different temperature conditions will be presented, and the advantages and limitations of both methodologies will be highlighted

Speaker

Dr. Jon Justo Urrutia holds a PhD in Civil Engineering by the University of Cantabria (Spain). His research field is focused on rock fracture mechanics, in particular, on the application of local criteria for the fracture assessment of rocks under different loading and temperature conditions. This research is performed within the Dept. of Ground and Materials Science and Engineering of the University of Cantabria, in collaboration with the TU Bergakademie Freiberg (Germany). He currently works at *SENER INGENIERÍA Y SISTEMAS* (Spain), and collaborates with the University of Cantabria in the publication of scientific articles. He has published more than 20 papers in prestigious journals and international conferences, and received several awards such as the SEMR (Spanish National Group of the ISRM) Prize in the field of rock mechanics, or the PhD Extraordinary Award by the University of Cantabria in the category of “Engineering and Architecture”.

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Differentiating cratering mechanisms in rock blasting based on geomechanical characterization

Abstract

Blast design precepts are founded on the notion of cratering by radial fracture expansion from the reflected tensile waves. Recent studies have demonstrated the prevalence of a different cratering mechanism in soft rocks, giving rise to elliptical breakout. Experimental trials have also shown the theoretical feasibility of convex breakout near the critical burden. This presentation revisits traditional cratering notions pertaining to blasthole damage zone, fracture initiation, and pressure wave propagation, interaction, and incidence. Three distinct cratering mechanisms are described conceptually and exemplified from small- and large-scale field experiments. The mechanistic descriptions provided for the different cratering mechanisms are emphasized through single hole blast (SHB) craters studied through experimental and numerical work. The geomechanical parameters and blasting agent characteristics are compared through a proposed SHB index. This latter index is used to differentiate cratering mechanisms, and predict the burden-dependent blasting behaviour. Energy balance-based solutions are derived from the SHB index to generate site-specific charge and blasthole diameter guidelines. From the performance index and derived guidelines, the presentation differentiates the fundamental differences in prevalent cratering mechanisms based on the type of geology considered.

Speaker

Dr. Jonathan Aubertin holds a Mining Engineering degree from McGill University (Montreal, Canada). From 2012 to 2021, he held various roles with mining Company Windsor Salt and US parent company Morton salt, working as a mine engineer, production engineer and general supervisor. Jonathan completed a PhD in Geological engineering in 2020 while working at the Weeks Island mine in Southern Louisiana. In 2021, Jonathan transitioned to an academic role as an assistant professor at École de Technologie Supérieure in Montreal, Canada. His research work focuses on rock blastability, rock mass characterization, and time dependency in rock engineering.