

Abstract

Quarrying in structurally complex crystalline rocks can create significant instability hazards where steep excavation faces intersect persistent discontinuities and seasonal groundwater. This study assessed five representative wall sections at Kaseve Quarry, Machakos County, Kenya, using the Bieniawski Rock Mass Rating (RMR89) system, field structural observations, laboratory-derived strength parameters, historical incident records and SLOPE/W-derived dry and wet-condition factors of safety (FS). Historical management records for 2015-2021 were used to reconstruct rockfall and blasting histories, while field, laboratory and groundwater investigations were undertaken from January 2022 to March 2024. After analyzing the discrete RMR89 ratings, wall-scale RMR values ranged from 28 at the Back Wall to 49 at the East Wall, classifying the investigated rock masses as Poor to Fair. Reported dry-condition FS values ranged from 1.08 to 1.68, while wet-condition values ranged from 0.82 to 1.35. The Back and South walls recorded wet-condition FS values below 1.0 and also exhibited the most pronounced cracking, seepage and historical rockfall evidence. Using the corrected RMR values and the SLOPE/W-derived dry FS dataset, exploratory ordinary least-squares regression gave $FS = 0.0254RMR + 0.399$ ($R^2 = 0.938$; $r = 0.968$; $p = 0.0067$; $n = 5$). Because FS is a calculated response and the sample contains only five wall-scale units, this relationship is interpreted as site-specific rather than predictive. The integrated evidence identifies the Back and South walls as the highest-priority areas for drainage improvement, re-benching, controlled blasting and systematic displacement and groundwater monitoring.