Journal Comment

Research on pillar strength

This edition of the *Journal* is the first of a series of planned themed editions. The South African mining industry faces several engineering challenges and it is hoped that these themes will stimulate research and groundbreaking papers. The first of these challenges is to develop local pillar strength equations and pillar design methodologies for hard rock mines. The shallow chrome, platinum, and manganese mines in South Africa typically use mechanized bord-and-pillar mining layouts. The older operations are gradually increasing in depth and this adversely affects the extraction ratios. The available design methodologies and pillar strength formulae dictate an increase in pillar size and a decrease in extraction ratio with depth. As these mining operations are vital to the South African economy, it is critical to maximize the extraction ratios and to ensure that the orebodies are optimally exploited. For outsiders, it is therefore somewhat surprising to learn that the layout designs are still mostly based on the Hedley and Grant pillar strength formula, which was originally developed for Canadian uranium mines in the early 1970s. Since then, very little research has been conducted to develop reef-type specific pillar strength formulae for the hard rock mines in South Africa. Considering the importance of this aspect, it is remarkable that a dedicated research programme to address this issue was not established a long time ago.

In contrast, extensive research into coal pillar strength was conducted in the aftermath of the Coalbrook disaster in 1960. The famous Salamon and Munro power-law strength formula was the result of this research effort. Interestingly, the selection of a power-law equation was inspired by laboratory and underground experiments that were conducted much earlier in the 1940s and 1950s. These studies indicated that the strengths of square pillars of the same height vary as the square root of their widths. The strengths of pillars of the same width also vary in inverse ratio to their height. This was generalized by Salamon in a power-law formula with the familiar exponents α and β. These exponents were subsequently calibrated using a database of failed and intact pillars. For the hard rock strength formula, Hedley and Grant used the same references from the 1940s and 1950s, as well as Salamon's work, to motivate the use of a power-law equation. It is not clear, however, if the calibrated exponents apply to the reef types in the South African mines. Almost no collapses have been reported in the Bushveld Complex mines using this pillar formula, except where weak clay layers were present. This may indicate that the current designs are possibly too conservative. It also presents a difficult problem to researchers, as a database of failed and intact pillars for bord-and-pillar layouts cannot be compiled. The statistical approach followed by Salamon to calibrate an empirical strength equation for coal can therefore not be replicated for hard rock. Attempts have been made to use small UG2 and Merensky Reef crush pillars for such an analysis, but most of these crush pillars are at a similar mining height, they are irregular in size, and it is difficult to classify them as failed or intact based on visual observations.

This special edition of the Journal is therefore a welcome addition to the available research literature on pillar strength and we thank the authors who contributed papers. The work includes interesting studies on the use of a limit equilibrium pillar model in a boundary element code, laboratory studies to calibrate these models, underground observations of pillar behaviour, the effect of confinement on pillar strength, and the effect of pillar shape. Professor John Napier made many of these studies possible with his TEXAN displacement discontinuity code, and the authors are deeply grateful for his contribution in this regard.

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