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Mine X (Portal C) jointed pillar numerical analysis

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Abstract

Mine X is a platinum mine in Southern Africa, mining Platinum Group Elements using the room and pillar mining method. Mine X is currently mining four portals that were named Portal A, Portal B, Portal C and Portal D. A pillar run was experienced at Portal B and it was found necessary to revise the original pillar design for all of Mine X's portals. All portals at Mine X were originally designed using the Hedley and Grant (1972) pillar design formula. This research focuses on the numerical analysis on Mine X Portal C pillar design. The main objectives being to evaluate the effects of joints and pillar size on pillar strength and to evaluate the appropriateness of the original pillar design.

The Universal Distinct Element Code (UDEC) software was chosen to conduct the analysis as it allows for a relatively large number of joints to be incorporated, and also permits to model tensile fractures. Propagation of tensile fractures is a key aspect of the pillar failure process in the model and reality alike. Therefore, significant effort has gone towards reproducing and calibrating this process based primarily on results of laboratory tests conducted on actual rock specimens collated at Portal C.

Since the type of modelling carried out in this project is relatively new in rock engineering, a review of the literature was deemed important. A study of existing approaches towards room and pillar designs was conducted so as to understand the mine's expectation from its original pillar design. Similar work previously done by others was studied and an optimum approach to follow was decided upon.

Data was collected from the mine that included test results on specimens, mapping data and pictures showing existing underground conditions. Previous work done on Mine X was also reviewed from which core logging data was obtained. All the collected raw data was processed to come up with information that could be used as inputs into the numerical models. It was decided to model the micro particles of the rock as voronoi tessellation and the cementation between these particles were modelled as voronoi contacts. Voronoi tessellation was essential to model tensile fracturing. Calibration against laboratory results was carried out for the purpose of obtaining voronoi properties that could be used in the model. It was decided to represent the joint network

using Discrete Fracture Network (DFN - a statistical description of fractures where a set of statistical parameters are defined and a joint set is generated based on those statistics) instead of explicitly modelling the mapped structures. The modelling process conducted in UDEC required some sensitivity analyses to be done to evaluate the effect of parameters such as velocity and mechanical damping.

Three sets of models were run, each set run on three different pillar sizes (2 m, 4 m and 6 m pillar widths). The first set was modelled as an intact pillar and the other two sets were modelled as jointed pillars. Each of the last two sets had a jointing network representing one of the two different geotechnical domains at the portal. The results from these models were compared.

The modelling results showed that pillar strength increases with increase in pillar size. Stiffness also increase as pillar width increases. However, a discrepancy was observed on the intact pillars where the 2 m pillar proved to be stiffer than the 4 m pillar. The existence of joints reduces intact pillar strength by 70% to 80%. The existence of the low angle joint sets translates into less stiff, more flexible and more ductile pillars.

Mine X is currently mining 4 m square pillars. According to the numerical modelling carried out, these pillars are too small with strengths ranging between 55 and 65 MPa. From the Hedley and Grant (1972) fomula used for the original pillar design, the mine is expecting pillars with average pillar strength of at least 95 MPa from the 4 m pillars. There is need for revising the design criteria and adjusting the mined pillar sizes to about 8 m wide pillars.