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Analysis of pillar scaling in the Magdalena Colliery, Dundee, South Africa

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Pillar scaling within coal mines leads to devastating effects such as roof falls that put the life of underground personnel at risk, as well as have a significant impact on the production of coal. Scaling occurs as spalling of coal from the rib-sides of the pillars within the seam as a consequence of the mining methods used, such as the drill and blast method, or due to zones of weakness within the coal, such as joint planes.

A study of the occurrence of pillar scaling within the Magadalena Colliery in Dundee, South Africa, has been undertaken in order to investigate the impact of pillar scaling on the originally designed factor of safety. Since 2008, a continuous miner has been used to extract bituminous coal from the Alfred and Gus seams of the Vryheid Formation by making use of the bord and pillar method. Prior to 2008, the drill and blast method was used as the method of extraction of the coal. Scaling of the carefully designed coal pillars alters the dimensions of the primary support structures thereby reducing the originally designed factor of safety. Analysis of the change in dimensions of coal pillars present within the Magdalena Colliery was done, in which measurements were made from the approximate position of the original rib-side to the new and current rib-side that has been created through scaling. The new safety factors were calculated using the standard Salamon and Munro [1] formulae, using the data related to the change in pillar dimensions. The original safety factors were then determined using unaltered pillar dimensions that are represented in panel maps. By comparing the original safety factors that were implemented during the time of coal extraction to those calculated for a specific period, a relationship between time and change in safety factor was established. Since analysis was carried out on pillars with two different dimensions (i.e. width to height ratio), an understanding of the scale effect was further established.

The results obtained from this study indicate that scaling is not in fact an exclusively time dependent variable, but instead relates directly to the properties of the rock mass itself. Thus, a coal seam that is highly fractured or subjected to cleating will suffer a greater deal of scaling than a seam that is relatively intact. The pillars consistent exposure to moisture over time accelerates the rate of scaling, more so if the pillar is highly jointed and highly cleated. Furthermore, the dimensions of the pillars created greatly influence the rate and degree of scaling. This was evident in the two different pillar sizes present in the mine and relates directly to the scale effect, in which pillars with smaller sizes resemble an intact rock specimen, while those with larger dimensions resemble a discontinuous rock mass.

Reference:

[1] Salamon and Munro (1967) J. S. Afr. Inst. Min. Metall., 68(2): 55-67