International Journal of Applied Engineering Research ISSN 0973-4562 Volume 11, Number 11 (2016) pp 7238-7239
© Research India Publications. http://www.ripublication.com

Prediction of Water Conducting Fracture Zone

Vladimir Gusev and Elena Maliukhina
Mining University, St. Petersburg, Russia.

Abstract

In the article presented overall information about calculation of water conducting fracture zone (WCFZ), describe influence of lithological composition for estimated height WCFZ. Comparative analysis of WCFZ height calculation also presented in the article.

Keywords: water conducting fracture zone, boundary curvature

INTRODUCTION

Mining operations influence the geomechanicals conditions of the rock mass. As a result, strength properties are reduced and fractures increase. The system of two fractures, vertical and horizontal ones, is called water conducting fracture zone (WCFZ). When a system of through fractures intersects the bottom of a water object (lake, river, aquifer etc), it may lead to a hydraulic connection of the mine with the water reservoir. That leads to increased water inflow to the mine and water irruption. The curvature of the last layer with hydraulic connection of vertical and horizontal fractures is called boundary curvature. One of the main parameters of WCFZ is height-the distance between top of mine and layer of boundary curvature.

CALCULATION OF WCFZ HEIGHT

One of the methods to calculate WCFZ height is the analysis of lithological composition for estimated boundary curvature, which shows that clay content reduces WCFZ[1]. Insitu data show the dependency of the boundary curvature on the clay content of the rocks (figure 1).

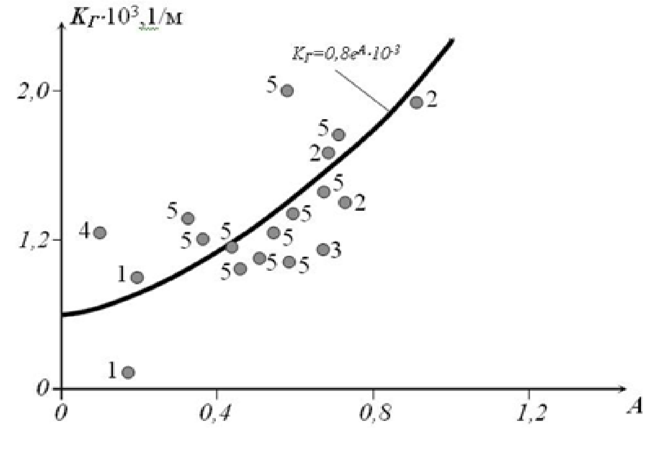

Figure 1: The dependence of the boundary curvature Kг on the clay content A. A-clay content; Kг-boundary curvature. 1-Suchansky pool; 2-Karaganda basin; 3-Donetskii Basin; 4-Kizelovsky pool; 5-Kuznetskii basin.

Clay content is presented in formula (1):

$$A = \frac{a_1 + a_2 \ldots + a_k}{H} = \frac{\sum_{i=1}^{k} a_i}{H}, \qquad (1)$$

A-overall clay content; a_1, a_2, …, a_k-content of clay beds; H – depth of the mind bed.

Statistical analysis gives a formula to calculate boundary curvature (Kг)(2):

$$K_Г = 0.8 \cdot e^A \cdot 10^{-3} \qquad (2)$$

WCFZ height depends on boundary curvature[2] (formula (3)):

$$H_T = 2\sqrt{\frac{m}{Kг}}, \qquad (3)$$

m-excavated thickness Kг-boundary curvature H_T-WCFZ height

Comparative analysis of WCFZ height calculation using formula (3) and insitu data shows that mean square deviation is ± 11 m, but in some cases deviation is 34m. Mean square deviation of boundary curvature is $\pm 0.35 \cdot 10^{-3}$ 1/m, in some cases up to $1.64 \cdot 10^{-3}$ 1/m. Such deviations can be explained by the influence of relative location of clay and non-clay layers on the development of WCFZ.

Calculating the center of thickness, distance from the top mine bed to the actual position of the center of distribution beds – Lф (figure 2)-has to be taken into account[3].

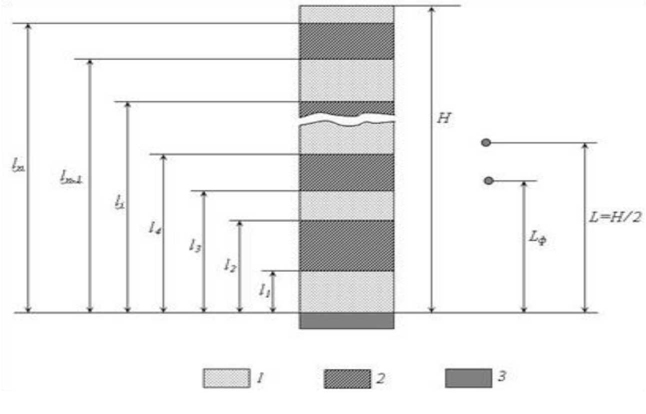

Figure 2: Scheme to calculate the relative position of the distribution center of bed thickness in a rock mass: ***l1, l2,..., ln*** –the distance from the top mine bed to separate rock layers ; ***Lф***-the distance from the top mine bed to the actual position of the center of distribution beds; ***L*** –the distance to the center of the distribution thickness beds, if the rock mass consists of the same thickness beds; ***H*** – the vertical distance from the top mine beds to the bottom loop of the water body or to the earth's surface; **1** – sandstone; 2-siltstone, mudstone; 3 –mine bed

That can be calculated by measuring the distance from the top mine bed to separate rock layers and number of beds (4).

$$L_{\phi} = \frac{l_1 + l_2 \ldots + l_n}{n} = \frac{\sum_{i=1}^{n} l_i}{n} \qquad (4)$$

Calculation of the distance to the center of distribution thickness beds, if the massive consist of the same thickness – L (5).

$$L = \frac{H}{2}, \qquad (5)$$

Relative distribution of the center bed thickness in a rock mass (c) can be estimated by formula (6):

$$c = \frac{L_{\phi}}{L}, \qquad (6)$$

c-relative distribution of the center bed thickness in a rock mass; Lф-the distance from the top mine bed to the actual position of the center of distribution beds; L –the distance to the center of the distribution thickness beds, if the massive consist of the same thickness beds;

c < 1 Big thickness beds located above in relation to the depth of mining operations. In that position WCFZ height is greater than the one with $c \approx 1$.

c > 1 Big thickness beds near the mine bed. In that position WCFZ height is smaller than height of water fractures zone with $c \approx 1$.

c ≈ 1 beds rock mass have the same thickness bed, or these thickness beds are symmetric with respect to the geometric center of rock mass.

Boundary curvature with account of center of thickness can be calculated by the formula (7)

$$K_{\Gamma c} = K_{\Gamma} \cdot c, \qquad (7)$$

$K_{\Gamma c}$-boundary curvature with account of center; K_{Γ}-boundary curvature without account of center (2); c-relative distribution of the center bed thickness in a rock mass;

Data on boundary curvature with account of center can help to calculate WCFZ height with more accuracy (8).

$$H_{Tc} = 2\sqrt{\frac{m}{K_{\Gamma c}}}, \qquad (8)$$

Comparative analysis of WCFZ height calculation using formula (8) and insitu data shows that mean square deviation is ± 2m, but in some situation deviation is 6m. Mean square deviation of boundary curvature is $\pm 0.08 \cdot 10^{-3}$ 1/m, in some cases the deviation is $0.31 \cdot 10^{-3}$ 1/m. Therefore the calculation of WCFZ height by formula (8) is more accurate.

CONCLUSION

Prediction of water conducting fracture zone is important for growth of mine safety. These methods can be used for stratified deposits to calculate the height of water conducting fracture zones and thus increase the safety of mining operation.

BIBLIOGRAPHY

[1] B. Gvirtsman, N. Kantselson, E. Bosheniatov, 1977, “Safe extraction of coal below water bodies”, Publisher: Nedra

[2] V. Gusev, 1999, “Geomechanics of the technogenic water conducting fractures”, Publisher: SPB

[3] V Gusev, A. Mironov, E. Anopov, D. Ilyukhin, 2011, “Geomecaniks analysis of developing of water condacting fracturing zone on undermine rock mass”, “Marksheiderskii vestnik”, vol. 5, p. 39-42