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The Effect of Valley Morphology on the K_0

Karim Talebi[1], Vahid Hosseinitoudeshki[2]
[1,2]Department of Civil Engineering, Zanjan Branch, Islamic Azad University, Zanjan, Iran
([1]Karim.talebi21@yahoo.com, [2]toudeshki@gmail.com)

Abstract- This paper presents numerical analysis of the effect of valley morphology on the K_0 by means of elasto-plastic finite element method. In numerical analysis, a 2D finite element program with software Phase2 is utilized. The valleys are modeled to a depth of 10, 20, 30, 40, 50, 60 and 70 meters and the influence of them on the value of K_0 is determined. The results of the evaluations show that by increasing depth of valleys, the value of K_0 around the valleys has increased and the maximum influence of valleys on the K_0 is related to tip valleys. Furthermore, by increasing distance from valleys, the influence of valleys on the K_0 has reduced.

Keywords- *Valley; K_o; Numerical analysis*

I. Introduction

One of the most important tasks in rock mechanics and engineering geology is to estimate of the value of K_0 and its effects on underground spaces. The K_0 is defined as the ratio between the major horizontal stress (σh) and the vertical stress (σv) (Goodman, 1989), being σv the weight of overburden. Gravity acting on topography creates differential stress, which, for sufficiently high, steep topography. In a study, Miller and Dunne (1996) showed topographically induced differential stress and analyzed the effect of topographic perturbation using a numerical model to examine the predicted displacement of ridges on either side of a valley. They presented that the mass of ridge provides considerable weight acting on either side of the valley, causing compression of the underlying material and downward vertical displacement, which is at a maximum beneath the ridge crest. This deformation cause displacement of the valley walls downward and away from the center of the valley and induces compressive stresses in the ridge crests and tensile stresses in the valley floor. The tensile stresses in valley bottoms are widely discussed (Amadei and Stephansson, 1997; Martel and Muller, 2000; Miller and Dunne, 1996; Molnar, 2004; Pan et al., 1994; Savage and Swolfs,1986), and the additional horizontal compressive stress in valley is discussed by Miller and Dunne (1996).

In this paper literature on topographical effects on the K_0 in valleys are reviewed.

II. Geomechanical properties of the rock masses

The rock mass properties such as the rock mass strength (σcm), the rock mass deformation modulus (Em) and the rock mass constants (mb, s and a) are calculated by the Rock-Lab program defined by Hoek et al. (2002). This program has been developed to provide a convenient means of solving and plotting the equations presented by Hoek et al. (2002).

In Rock-Lab program, both the rock mass strength and deformation modulus are calculated using equations of Hoek et al., 2002, and the rock mass constants are estimated using equations of Geological Strength Index (GSI) (Hoek et al., 2002) together with the value of the shale material constant, mi. Also, the value of disturbance factor (D) that depends on the amount of disturbance in the rock mass associated with the method of excavation, is considered equal to 0.5 for the rock masses, it means these rocks would be disturbed slightly during blasting.

Finally, the shear strength parameters of the rock mass (C and φ) for the rock masses are obtained using the relationship between the Hoek–Brown and Mohr–Coulomb criteria (Hoek and Brown, 1997). The geomechanical parameters of limestone rock masses is obtained and presented in Fig. 1.

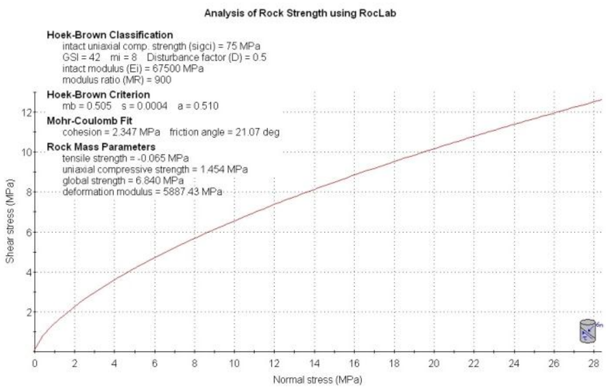

Figure 1. The geomechanical parameters of limestone rock masses

III. Numerical analysis of the influence of valleys on the K_0

Numerical analyses are done using a two-dimensional hybrid element model, called Phase2 Finite Element Program (Rocscience, 1999). In this finite element simulation, based on the elasto-plastic analysis, deformations and stresses are computed. These analyses used for evaluations of the stress in the rock masses. The geomechanical properties for these analyses are extracted from Fig. 1. The generalized Hoek and

Brown failure criterion is used to identify elements undergoing yielding and the displacements of the side of valleys.

To simulate the valleys in the limestone rock masses, a finite element models is generated with valleys to a depth of 10，20，30，40，50，60 and 70 meters (for example Fig. 2) and six-nodded triangular elements are used in the finite element mesh. The dimensions of models are considered 100 and 300 meters and the value of K_0 1.4 is loaded to models.

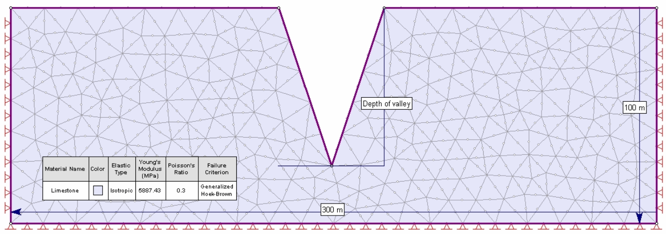

Figure 2. The modeling of valleys to a depth of 75meters

By run of models, the values of K_0 around the valleys in the depths (h) of 25, 50 and 75 meters and in different distances (d) from valleys is determined and the obtained results are shown in Figs. 3 to 9.

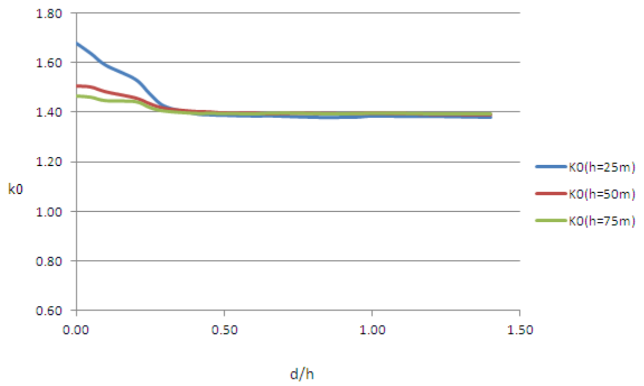

Figure 3. The values of K_0 around the valley with depth of 10 meters (h is meseared depth of K_0 and d is distance from the valley)

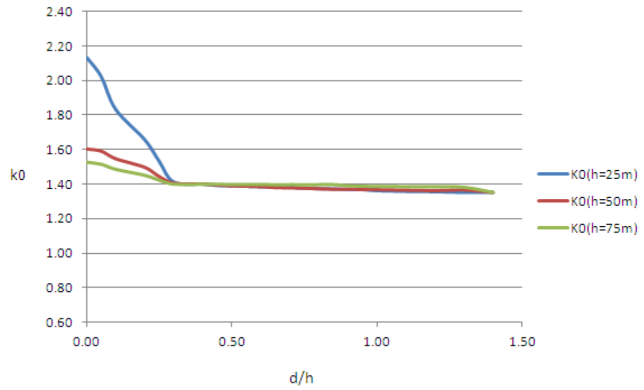

Figure 4. The values of K_0 around the valley with depth of 20 meters (h is meseared depth of K_0 and d is distance from the valley)

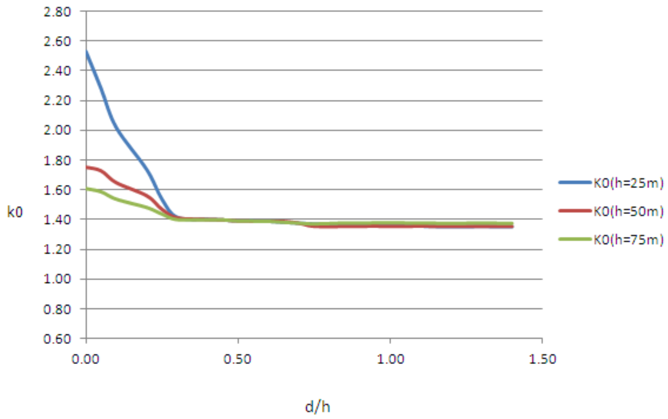

Figure 5. The values of K_0 around the valley with depth of 30 meters (h is meseared depth of K_0 and d is distance from the valley)

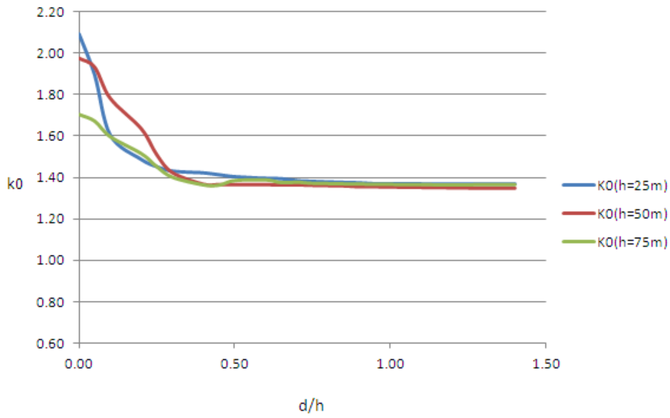

Figure 6. The values of K_0 around the valley with depth of 40 meters (h is meseared depth of K_0 and d is distance from the valley)

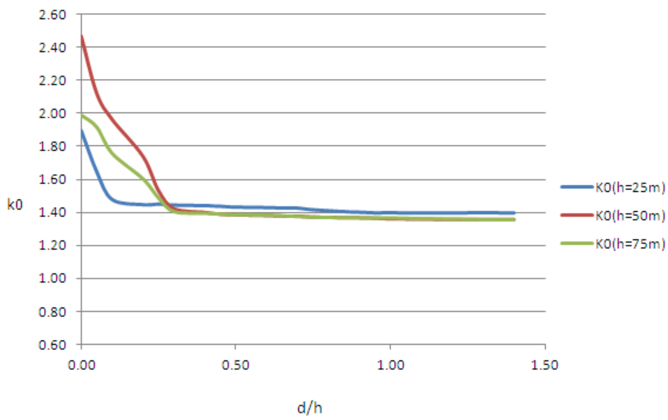

Figure 7. The values of K_0 around the valley with depth of 50 meters (h is meseared depth of K_0 and d is distance from the valley)

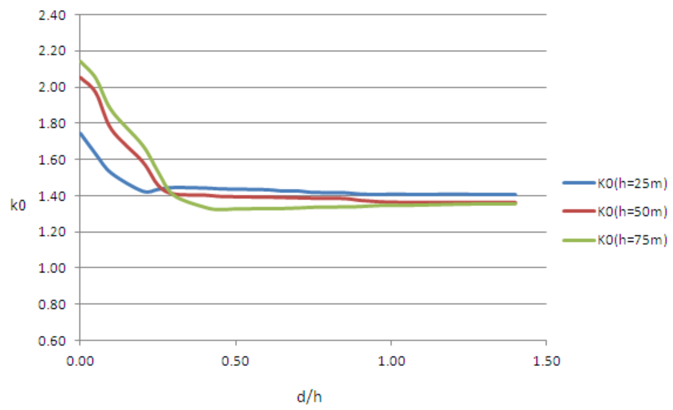

Figure 8. The values of K_0 around the valley with depth of 60 meters (h is meseared depth of K_0 and d is distance from the valley)

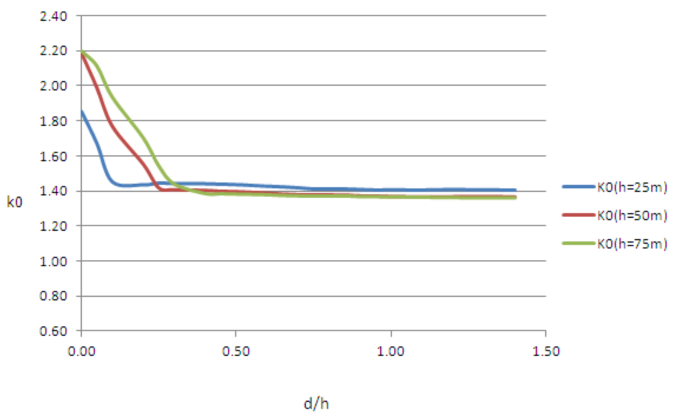

Figure 9. The values of K_0 around the valley with depth of 70 meters (h is meseared depth of K_0 and d is distance from the valley)

As the above diagrams show, by increasing depth of valleys, the value of K_0 around the valleys has increased. Furthermore, by increasing distance from valleys, the influence of valleys on the K_0 has decreased so that, this effect is to d/h of 0.3. Also, the diagrams show that the maximum changes of K_0 have taken place in the tip of valleys.

IV. CONCLUSIONS

This study provides an estimation of the effect of valleys on the values of K_0. The following conclusions could be noted:

- By increasing depth of valleys, the value of K_0 around the valleys has increased.

- By increasing distance from valleys, the influence of valleys on the K_0 has reduced.

- The maximum influence of valleys on the K_0 is related to tip valleys.

- The effect of valleys on the K_0 is to d/h of 0.3.

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