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The effect of pore pressure on the number of ruptured joints in the rock slopes

Vahid Hosseinitoudeshki* and Amirhossein kayalha

Department of Civil Engineering, Zanjan Branch, Islamic Azad University, Zanjan, Iran

***Corresponding author*:** Vahid Hosseinitoudeshki

ABSTRACT: The behavior of rock masses on the nature is affected by properties of the fractures in rock masses. Therefore, the joints and faults affect the engineering behavior of rock masses and different consequences are followed. In this paper, the rock slope with dip of 60 degree is modeled in rock mass consisting of jointed tuffs. In this modeling the joints with different dips of 0, 30, 45, 60 and 90 degrees are analyzed in static and quasi- static state by using Phase2 software. The obtained results h show that by increasing pore pressure, the number of ruptured joints in slope increased both in static state and quasi-static with this difference that in a fixed pore pressure, the number of ruptured joints in semi static state are more than static state.

***Keywords*:** Rock slope, Pore pressure, Joint, Static, Quasi- static.

INTRODUCTION

Stability of slopes and excavation of rocks is one of the important problems in underground structures engineering. In research conducted by Cengiz, (2012) effect of seams along the variable joints direction parallel to the ultrasonic wave propagation in rocks is studied. Kemthong (2006) in his master's thesis determine the shear strength of rock joints based upon physical properties. Heavily jointed rock mass behaviour of all researchers is emphasized.

Zhao, (2008) in an article examines that the rock masses are contain from discontinuities in different sizes that cracks and micro fissures in the earth are classified. The results of this study indicate that under the circumstances, the magnitude of the wave transmission coefficient not only by increasing the number of failures increases but also become larger. In this paper, the effect of pore pressure on the number of yielded joints in the rock slopes is investigated.

Geomechanic parameters of jointed tuff rocks

In this paper, the geomechanic parameters of jointed tuffs regarding to the intact rock properties and discontinuities in the rock are obtained by Roclab software defined by Hoek, (2002). Roclab software presented by Rocscience is used for estimating strength parameters of rocky mass.

Table 1. Mechanical properties of jointed tuff rocks

Roclab program's input and output							
Hoek Brown Classification				Hoek Brown Criterion			
σci (Mpa)	GSI	mi	D		mb	s	a
Intact Uniaxial Compressive Strength	Pick GSI Value			Pick mi Value			Disturbance Factor
175	50	13	0.7		0.833	0.0007	0.506
Mohr-Coulomb Fit				Rock Mass Parameters			
C (Mpa)	φ(degree)	σt(Mpa)		σc(Mpa)		σcm(Mpa)	Edm(Mpa)
Cohesion	Friction angle	Tensile strength		Uniaxial compressive strength		Global strength	Deformation modulus
0.506	50.36	- 0.15		4.482		20.994	5632.3

Numerical modeling

In this research, by using Phase2 software (Rocscience, 1999), slope with dip of 60 degree in jointed tuff rocks are modeled. The joints in the slope are considered by different dips of 0, 30, 45, 60, 90 degrees and also the pore pressure in joints in the following values are considered: 0, 0.05, 0.1, 0.125, 0.15, 0.2, 0.25, 0.3, 0.35, 0.5 Mpa.

In Fig. 1, an example of modeling for slope with 60 degree is presented. In all models and in different dip of joints, the height of slope is 80 m, and Veneziano joint network model that is used for numerical analysis is based on a Poisson line process. It adapts the Poisson process to generate joints of finite length (Dershowitz, 1985).

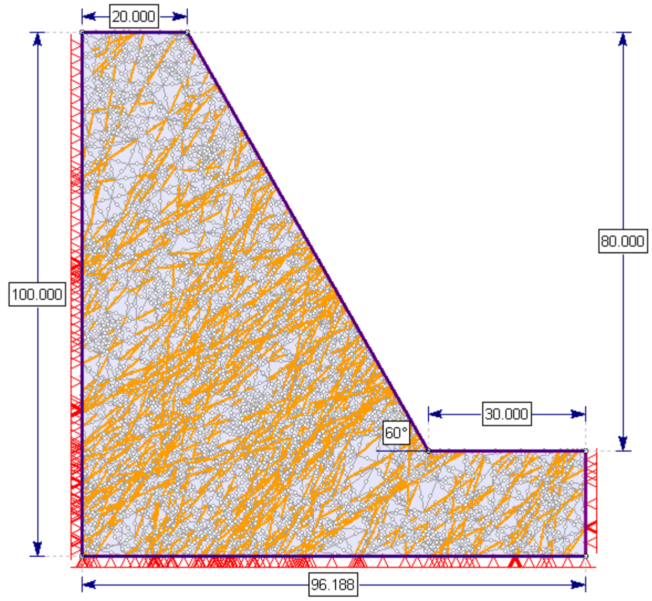

Figure 1. Finite element mesh and the Veneziano joint network

Analysis of resulting output from numerical modeling

the obtained results of numerical modeling show that by increase of pore pressure in joints, the number of yielded joints are increased (Fig. 2). In the areas that joints are ruptured by increasing pore pressure, the shear strength of joints decreased and led to tension or shear rupture (Fig. 3) and the joints that are ruptured are wider and at last led to slope failure.

The most important effect of water pressure on the jointed rocks is decreasing the shear strength of rocks due to reduce of vertical stress on the surface of joints, and this is shown by following relation:

$$\tau = C + (\sigma_n - u)\tan\phi$$

In the quasi-static state, the seismic acceleration that is applied to model is equal to 0.35g and deformations are analyzed in this state.

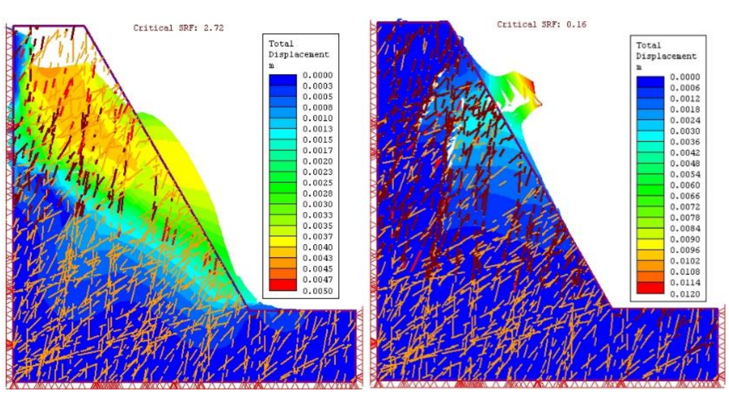

Figure 2. The ruptured joints in slope with dip of 60 degree and pore pressure of 0 Mpa (left)

The ruptured joints in slope with dip of 60 degree and pore pressure of 0.5 Mpa (right)

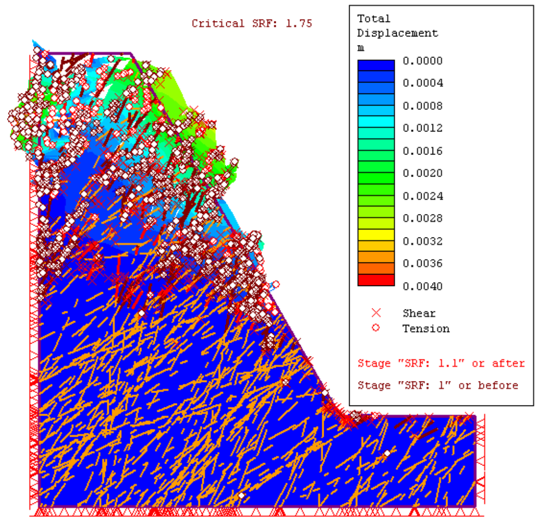

Figure 3. The ruptured joints that are affected by shear, tension and increase of pore pressure

All of the obtained results from numerical analysis in static and quasi-static state are presented by graphs in Figs. 4, 5 and 6. Figure 4 and Fig. 5 show that in slope with different dips of joints, by increasing the pore pressure, the numbers of joints that reach to ruptures are increased.

Figure 6 shows that in slope with dip of 60 degree and joints with fixed dip (joints with dip of 60 degree) the number of ruptured joints in the quasi-static state is more than static state.

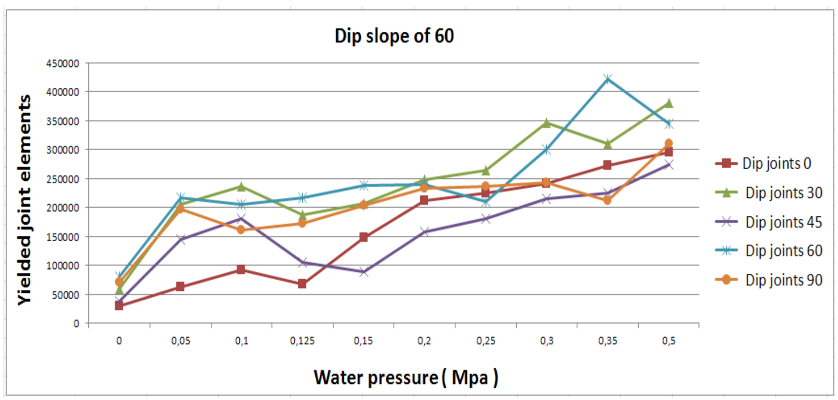

Figure 4. The number of yielded joints in different pore pressures in the static state

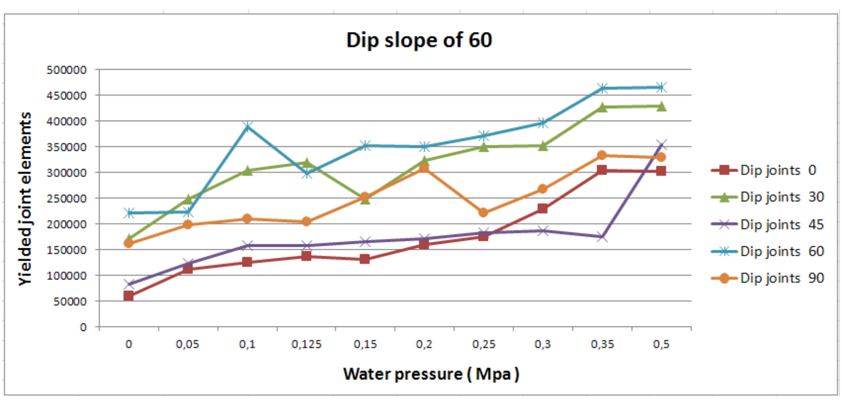

Figure 5. The number of yielded joints in different pore pressures in the quasi-static state

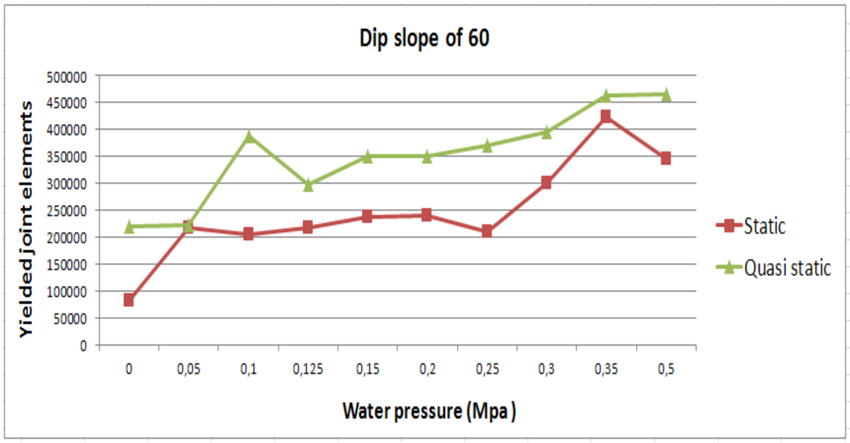

Figure 6. The number of ruptured joints in static and quasi-static states (dip of slope is 60 degree and dip of joints is 60 degree)
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CONCLUSION

In this paper the effect of pore pressure on the number of yielded joints in the rock slopes are evaluated. The analyzing results are as the followings:

-In the static and quasi-static, by increasing pore pressure, the number of ruptured joints is increased in slope.

-In the fixed pore pressure, the number of ruptured joints in slope in quasi-static state is more than static state.

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