EXPERIMENTAL AND NUMERICAL SIMULATION OF THE EFFECT OF NON-PERSISTENT JOINT ON THE FAILURE PATTERN AND FAILURE LOAD OF SAMPLES

Vahab sarfarazi[1], Mohammad Ghafari[2], Hadı Haeri[3*]

[1]*Academic member, Hamedan University of Technology, Hamedan, Iran*
E-mail: sarfarazi@hut.ac.ir
[2]*Research Scholar, Hamedan University of Technology, Hamedan, Iran.*
[3]*Young Researchers and Elite Club, Bafgh Branch Islamic Azad University, Bafgh, Iran.*
E-mail: haerihadi@gmail.com

Abstract: Investigation of behaviour of non-persistent joint is important in rock structure stability. This leads to improvement in rock engineering project design. Rock bridges in non-persistent joint increase shear strength of failure surface. For investigation of shear behaviour of rock bridges, 24 gypsum samples with dimension of 10 cm × 10 cm × 5 cm were prepared. The joint lengths in various samples are different but in the one sample the joint length are similar. Joint lengths change from 1 cm to 4 cm. in each joint length, joint angularity was 0, 15, 30, 45, 60, 75 degrees. These samples were under uniaxial compression test. The results show that failure pattern was affected by joint length, joint angularity and rock bridge length while failure load was controlled by failure pattern.
Concurrent with experimental test, numerical simulation was performed using PFC2D software. The joint lengths in numerical model change from 1cm to 4 cm with increment of 1cm. In each joint length, the joint angularity is 0° and 45°. Failure pattern in numerical model was similar to experimental sample while failure load in numerical model was more than experimental outputs.

Keywords: : non-persistent joints, crack growth, rock bridge, uniaxial testing.

INTRODUCTION

Non-persistent joint has important effect on the failure mechanism of rock masses. Stress intensity at tip of the joint can lead to secondary crack propagation [1, 2, 3, 4]. Wong [5] investigate the shear behaviour of non-persistent joint. Ghazvinian [6] investigate the shear mechanism of rock bridge. The results show that rock bridge continuity has important effect on the shear strength. Zhang [7] investigate the failure pattern of non-persistent joint using numerical simulation. Ghazvinian [8] simulate the shear failure behaviour of non-persistent joint using PFC2D. The results show that the shear bands increase by increasing of the rock bridge length. Bobet [9] investigate the crack coalescence under uniaxial compression test.

METHODS

24 gypsum blocks with dimension of 10*10*5 cm have been built in total. For this purpose

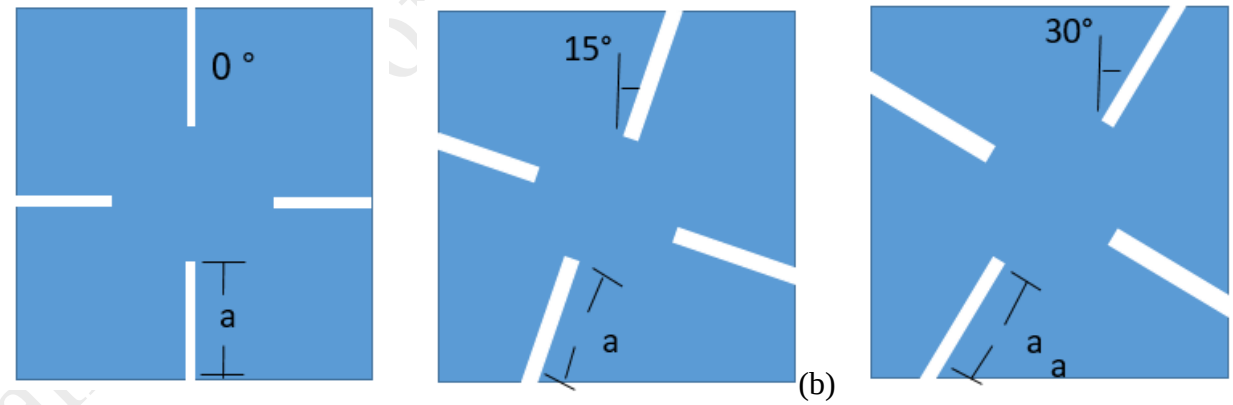
special cast and stainless steel profile was used (Fig 1).

* Corresponding author

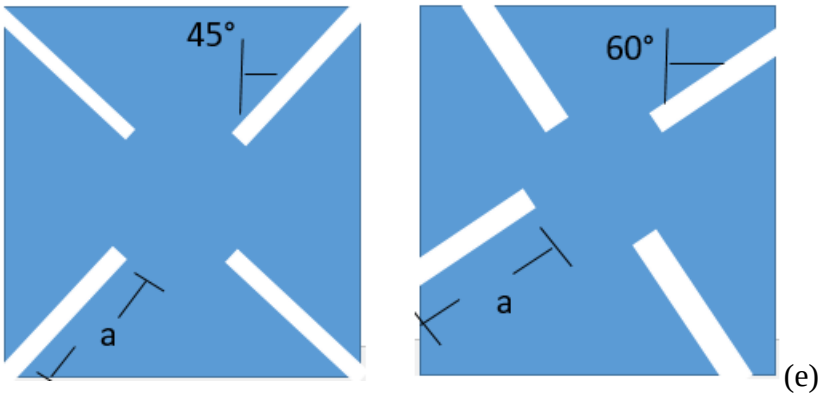
(a) **(b)**

Fig 1. a) The cast used for sample preparation, b) the profile used for joint creation.

The joint length were 1 cm, 2cm, 3cm, and 4 cm while the joint angularities were 0°, 15°, 30°, 45°, 60° and 75°. Fig 2 shows the schematic view of the prepared samples. These samples are tested by uniaxial testing machine (Fig 3).



(a) (b) (c)



(d) (e) (f)

Fig 2 The schematic view of the prepared samples.

Fig 3. Uniaxial testing machine

FINDINGS AND ARGUMENT

When joint length are 1 and 2 cm, the results shows that two types of failure occurred in the samples. The first one takes place in intact portion of rock (fig 4 a and b) and second one in both of the intact area and neighbouring joint (fig 4 c,d, e and f).

(a)

(b)

(c)

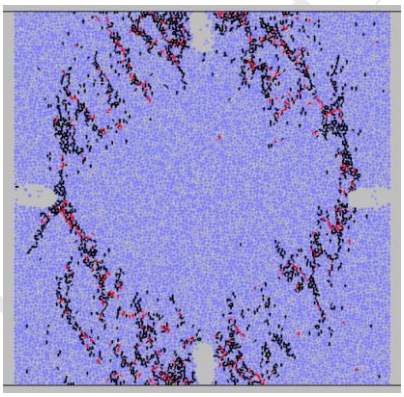
(d)

(e)

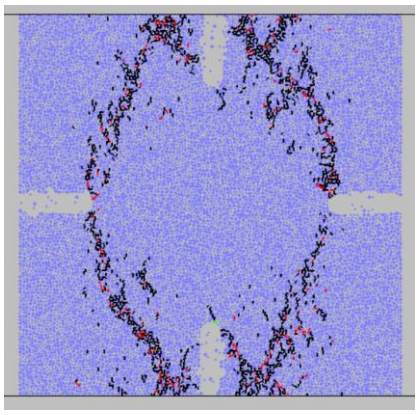
(f)

Fig 4. The failure pattern in the samples.

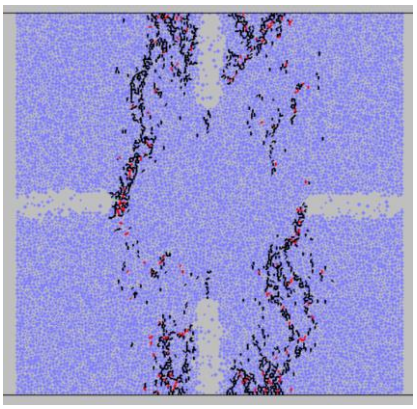
Numerical simulation shows that a good accordance is established between numerical outputs (fig 5) and experimental results.



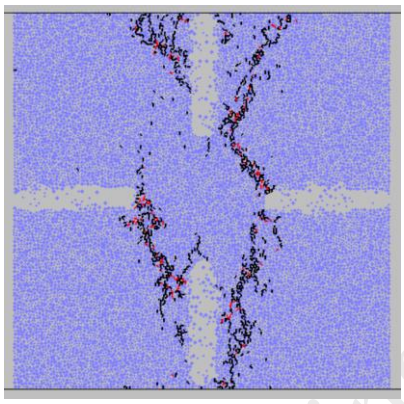
(a)



(b)



(c)



(d)

Fig 5. Failure pattern in numerical simulation.

CONCLUSIONS

The results shows that two type of failure occurred in experimental tests. The first one occurred from intact portion of rock and second one occurred in both of the intact area and neighbouring joint. Numerical simulation shows that a good accordance is established between numerical outputs

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