International Research Journal of Applied and Basic Sciences
© 2014 Available online at www.irjabs.com
ISSN 2251-838X / Vol, 8 (7): 839-843
Science Explorer Publications

The effect of loading on the stability of rock slopes

Mohit Jannesar[1]، Vahid Hosseini toudeshki[2]*

1. Department of Civil Engineering، Zanjan Branch، Islamic Azad University، Zanjan، Iran
2. Department of Civil Engineering، Zanjan Branch، Islamic Azad University، Zanjan، Iran

Corresponding Author email: toudeshki@gmail.com

ABSTRACT : The stability of rock slopes is affected by such elements as excavation and loading on the slopes. In order to examine the effect of loading on the stability of slopes, certain slopes withdips of 30, 45, 60 and 75 degrees have been modeled, using Phase 2 software. Then, certain loads of 1, 5, 10, 15 and 75 Mpaon three parts of slopes namely up, middle and down of slopeswere done. Regarding each case, the stability of slopes has been determined by obtaining thestrength reduction factor (SRF). The results obtained from this study have revealed that stability of slopes has been decreased by loading on the slopes and that the effect of loading on various parts of the slope is different. In slopes with low dip, loading on the down part of the slopes has the least effect on instability of the slopes. However, with increasing dip of slopes, loading on the down part of the slopes shall have the most effect in instability of slopes.
Key words: Rock slopes, Strength Reduction Factor (SRF), Phase 2, Loading

INTRODUCTION

The slope stability analysis has many applications in the design of rock slopes, roadsand open pits structures.Because, the design engineer should consider the safety and the construction cost simultaneously, it is important to determine rock slope stability in the preliminary design stage of construction. A number of methods have been suggested by researchers (Kirsten, 1982; Minty and Kearns, 1983; Caterpillar, 1988; Pettifer and Fookes, 1994) to evaluate the stability issues of slopes. These methods consider a different set of geotechnical parameters such as weathering, discontinuity spacing and groundwater.

Stability by strength reduction is a manner that the factor of safety is determined by weakening the soil or rock in stages in an elastic-plastic finite element analysis until the slope fails. The factor of safety is considered to be the factor by which the soil or rock strength needs to be reduced to reach failure (Dawson et al., 1999; Griffiths and Lane, 1999).

In the Strength Reduction approach, the soil or rock strength is dummy reduced, and so there is a need to redistribute the stresses. This can be done by the stress redistribution algorithm, and so this option can be indirectly used to do a strength reduction stability analysis.

In this research, in order to study the parametric loading effect on stability of rock slopes, certain slopes of different dipsin Dolomitic rocks were modeled. Then, loadings at three parts of slopes (up, middle and down) were done.

Geomechanical parameters of dolomitic rocks

In this study, the geomechanical parameters of the jointed dolomitic rock masses in Taham-Chavarzagh road, located in the Zanjan province, were obtained by using Roclab software (Hoek et al. 2002). These parameters are obtained based on The Hoek-Brown failure criterion and it is presented in Fig. 1.

Modeling of rock slopes

To study the effects of excavation on the stability of rock slopes, slopes with dips of 30, 45, 60, and 75 degrees in the jointed dolomitic rock masses were modeled. (Fig. 2)The Venezianojoint network model is used for numerical analysis (Fig. 2) and this model is based on a Poisson line process. It adapts the Poisson process to generate joints of finite length (Dershowitz, 1985).

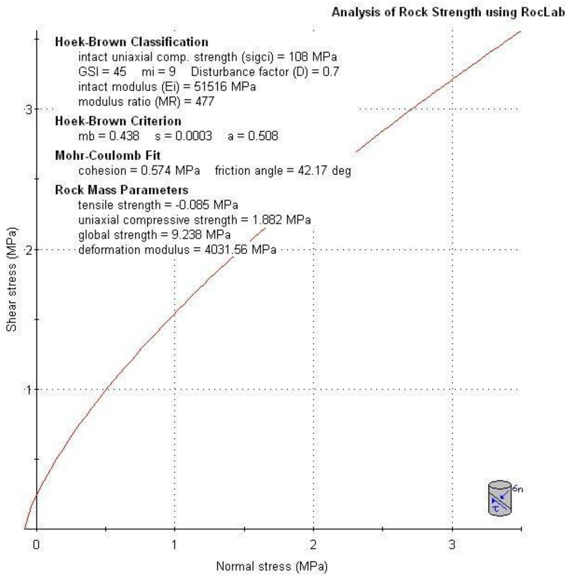

Figure1. The geomechanical parameters of dolomitic rock mass

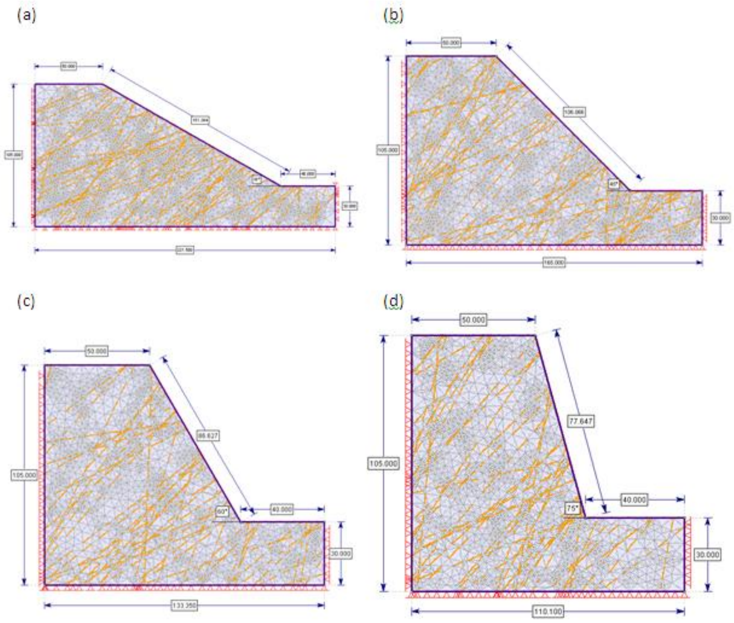

Figure 2. The models of slopes with dips of 30 degrees (a), 45 degrees (b), 60 degrees (c) and75 degrees (d), the Venezianojoint network is also shown.

By run the made models, the critical strength reduction factor (SRF) of slopes was obtained. The respective quantity has been obtained for the slope of 30 degrees as 4.23, for the slope of 45 degrees as 2.8, for 60 degrees as 2.08 and for slope of 75 degrees as 1.55 respectively.

Loading on Slopes

At this stage, the loads of 1, 5, 10, 15 and 75 Mpaon three parts of slopes have been done andthe critical strength reduction factor (SRF) has been obtained. The loadings for the slope of 45 degrees have been shown in Figs. 3 to 5.

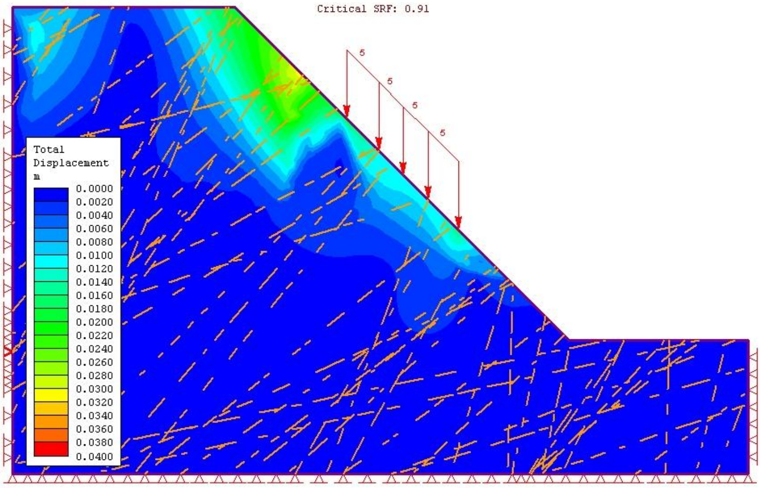

Figure 3. The loading on the up of 45 degrees slope (the critical SRF is equal to 1.67)

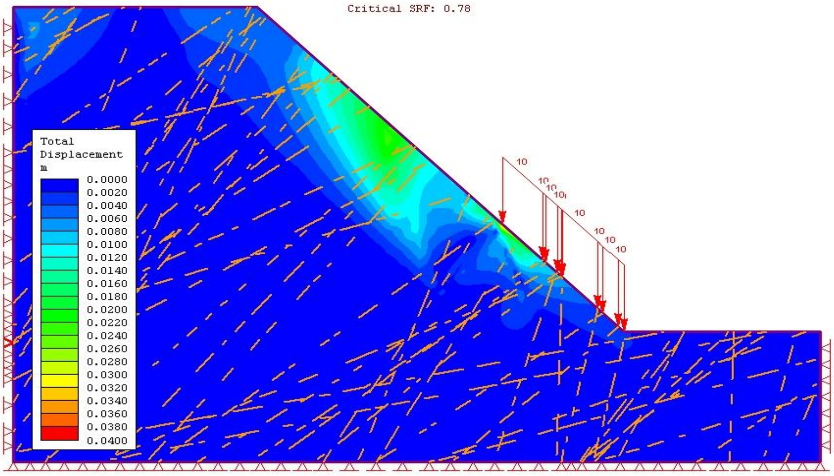

Fig. 4. The loading on the middle of 45 degrees slope (the critical SRF is equal to 0.91)

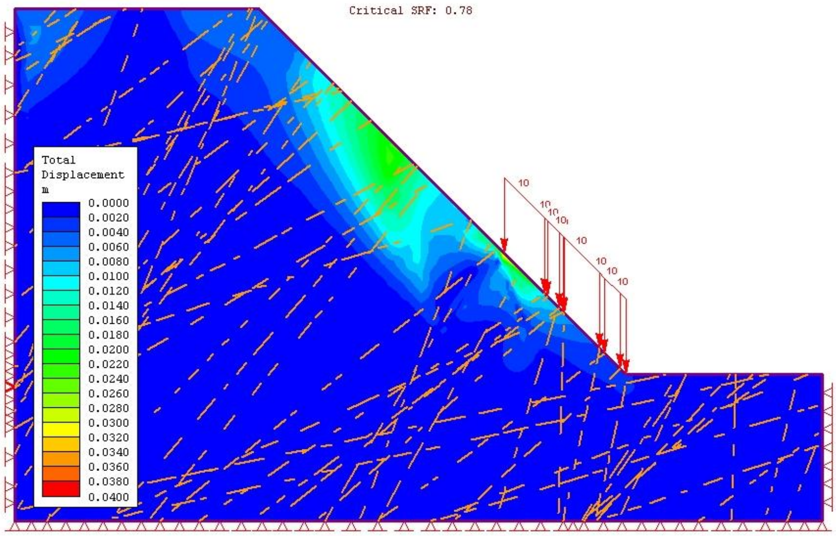

Fig. 5. The loading on the down of 45 degrees slope (the critical SRF is equal to 0.78)

The values of SRF obtained for all of the loading slopes are presented to diagrams shown in Figs. 6 to 9. In order to normalizing the loads on slopes,the loads are divided by the vertical stresses in slopes and the normal values of loads are obtained and in the following diagrams are shown.

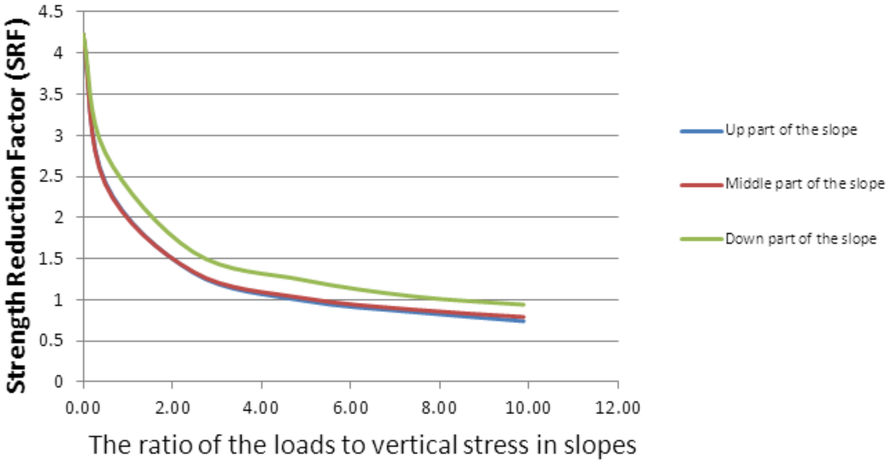

Fig. 6. The diagram shows the amounts of SRF versus the ratio the loads to vertical stress on the slope with dip of 30 degrees.

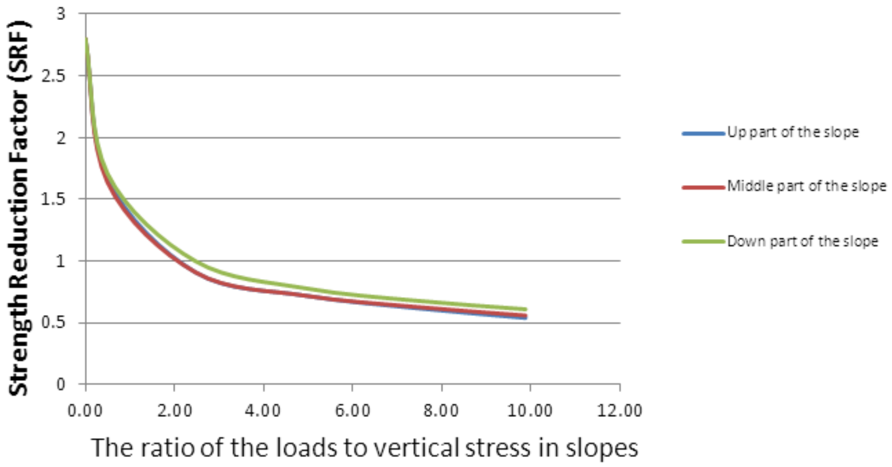

Fig. 7. The diagram shows the amounts of SRF versus the ratio the loads to vertical stress on the slope with dip of 45 degrees.

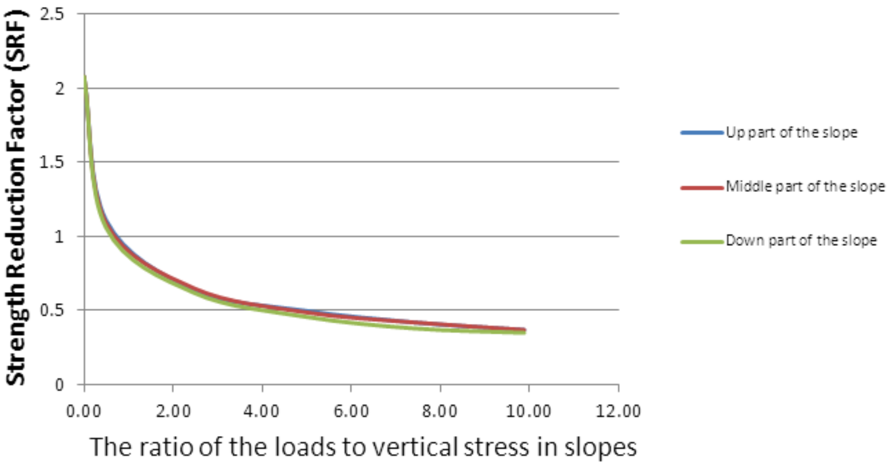

Fig. 8. The diagram shows the amounts of SRF versus the ratio the loads to vertical stress on the slope with dip of 60 degrees.

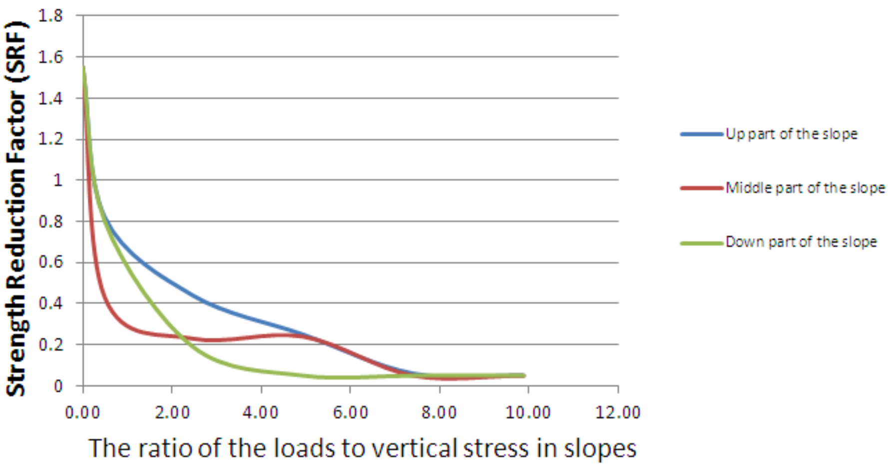

Fig. 9. The diagram shows the amounts of SRF versus the ratio the loads to vertical stress on the slope with dip of 75 degrees.

As it has been shown in the above diagrams, with increasing of loading on all slopes, thecritical strength reduction factor (SRF) will be decreased. Considering all slopes, the most decrease is seen in the loading limit of 0 to 2. More loading than what has been mentioned (0 to 2) has less effect in instability of slopes. Moreover, considering the slopes with dips of 30 degrees and 45 degrees, loading on the parts of up, middle and down of slopes has the most effect on instability of slopes. Instead, in the slope of 60 degrees, loading on all three parts of the slope shall have a same effect. In the slope with an angle of 75 degrees, loading on the middle and down of slope has the most effect on instability of the slope. The results are interpreted in such a way as loading on the down part of the low dip slopes is as increasing the weight of the slope footing foundation.This shall decrease the instability of slopes. Instead, considering high dip slopes, loading on the downpart of the slope shall increase gravitational instability and eventually increase the slope instability.

CONCLUSION

In this research that with aim to analysis of the effect of loading on different parts of slopes is done the following results are obtained:

By loading on slopes, the strength reduction factor (SRF) has been decreased and magnitude of incoming loads has a direct effect on their instability.

Loading on different parts of the slopes has left a different effect on instability of slopes.

With increasingdip of slopes, loading on the down part of the slopes has the most effect on their instability.

Regarding low dip slopes, loading on the down part has the least effect on instability of slopes.

REFERENCES

Caterpillar.1988.Caterpillar Performance Handbook, 19th ed. Caterpillar Tractor Company, Peoria, IL, USA.

Dawson EM, Roth WH, Drescher A. 1999. Slope Stability Analysis by Strength Reduction, Geotechnique, 49(6), 835-840.

Dershowitz W. 1985. Rock Joint Systems., Ph.D. Thesis, Massachusetts Institute of Technology, Cambridge, MA.

Griffiths DV, Lane PA. 1999. Slope Stability Analysis by Finite Elements, Geotechnique, 49(3), 387-403.

Hoek E, Carranza-Torres C, Corkum B. 2002. Hoek–Brown Failure Criterion- Edition, Rocscience.

Kirsten HAD. 1982. Aclassification system for excavation in natural materials. Civil Engineer in South Africa, 24, 293–308.

Minty EJ, Kearns GK. 1983. Rock mass workability. In: Knight, M.J., Minty, E.J., Smith, R.B. (Eds.), Collected Case Studies in Engineering Geology. Geological Society of Australia, Special Publication, 11, 59–81.

Pettifer GS, Fookes PG. 1994.A revision of the graphical method for assessing the excavatability of rock. Quarterly Journal of Engineering Geology 27, 145–164.