S1–06

The Stability Estimation of Rock Mass Surrounding Tunnel by Strength Reduction FEM

Jong Tok Yong[*], *Jang Ui Jun*

Faculty of Resources Exploration Engineering, Kim Chaek University of Technology, Pyongyang, DPRK
[*]Corresponding author: Email: jdy7459@star–co. net. kp

The stability estimation of rock mass surrounding tunnels proposed in this paper is performed with the results of elastic–plastic FEM analysis based on the Mohr–Coulomb strength criterion and the strength reduction technique using ABAQUS.

The surrounding rock mass is idealized as an elastic, perfectly plastic material with a cohesion and an inner frictional angle. The shear strength parameters of rock mass surrounding tunnels is continuously reduced so the rock mass turns into the critical state and the calculation stops through the calculation of the elasto–plastic FEM strength reduction using ABAQUS. Users can obtain the plastic zone contribution and the factor of strength reserve from the calculation results. In ABAQUS, the shear strength parameters of material can be reduced using field variable F_v.

It seems that the stability estimation of rock mass surrounding tunnels is the process where we judge the failure state of the rock mass and at the same time we determine the factor of safety of strength reserve of that time. In order to judge the critical failure state, the rock mass material is assumed to be ideal elasto–plastic material. And the critical failure state is judged by monitoring the process of change of the value of the equivalent plastic strain. In other words, we regard the beginning moment when the equivalent plastic strain value changes in excavation areas as the critical failure state. Next, in order to determine the factor of safety, we find a sudden change point on the relative curve between the strength reduction coefficient and the value of the equivalent plastic strain. This sudden change occurs in conformity with the moment when the equivalent plastic strain comes into being in the excavated area. It can be determined that the reduction coefficient F_v of the sudden change point is just the factor of safety.

From our stdudy, it is proved that in the case of the stability estimation of rock mass surrounding tunnels the critical state cannot be judged nor determine factor of safety using the criteria applied to the stability estimation of the slope. In conclusion, we believe that it is difficult to determine the factor of safety using the criterion by non–convergence of finite element calculation and sudden change point of horizontal displacement.

Careful attention must be paid to this method of determining the factor of safety: when the sudden change point on the curve is monitored, the change relation between the reduction coefficient and the equivalent plastic strain for the sudden change point must be confirmed with numerical values. Namely, it must be confirmed that the point where the plastic strain of some values begins to occur from zero and the sudden change point is a meeting point.

According to this criterion we can overcome result errors caused by different FEM programs and FEM non–convergence criterion. And we can know the further change of the surrounding rock mass status after local destroying. And we can monitor various points of the surrounding rock mass in different parts of the tunnel, which helps us to know not only the local instability but also the total instability.

In our study, we considered the total process of equivalent plastic strain evolution in surrounding rock mass with the strength reduction process and, at the same time, determined its factor of safety. We have applied the sudden change of the equivalent plastic strain to estimate the stability of rock mass surrounding tunnel. It appears that this is the general stability estimation of rock mass surrounding tunnels.