S1–08

3D Numerical Modeling for Tunnel in Anisotropic Rock by FEM

Hwang Ryong Hyon[1*], *Ri Yong Il*[2]

[1]Faculty of Mining Engineering, Kim Chaek University of Technology, Pyongyang, DPRK
[2]Faculty of Anthracite Mining Engineering, Pyong Song Coal Mining University, Pyongsong, DPRK
[*]Corresponding Author: Email: hrh69212@star–co. net. kp

The general method for analyzing a 3D anisotropic rock tunnel is to edit an elastic matrix in a partial coordinate system, but its derivation is too complex to be used. There are few examples where 3D models are calculated by FEM software, when there is a difference between the directions of axis and rock anisotropy.

This paper proposed a simple method to analyze the 3D tunnel with different anisotropic directions of rock, where it is used the function of setting two coordinate systems of FEM, instead of an elastic matrix of anisotropic material in the partial coordinate system.

In order to determine the elastic matrix in the partial coordinate system, we set the main and partial coordinate systems by using an auxiliary coordinate system of FEM software such as COMSOL and ANSYS. The partial coordinate system indicates the anisotropic direction of material, but the geometric modeling and the boundary condition are handled in the main coordinate system. Software automatically converts the relation between two coordinate systems, allowing the anisotropic direction of material to be considered simply.

A detailed method using COMSOL Software is as follows.

In the first step, an auxiliary coordinate system is set, where all physio–mechanical parameters of anisotropic material such as elastic modulus, Poisson ratios, compressive, tensile and shear strengths of three directions are given. Next, the geometric modeling and boundary settings (load and constraint) are made in the global coordinate system (the main).

The material model is set as the orthotropic and its stress and displacement are analyzed for different rotation angles of axes X, Y, and Z in the auxiliary coordinate system. Here the rotation angles of X, Y, and Z axes in the auxiliary coordinate system indicate the corresponding direction of material anisotropy.

This method based on the automatic transfer function of coordinate in FEM Software gives an easy way of calculation of a 3D anisotropic model without needs of editing complex elastic matrix in the partial.

In order to verify the proposed method, we considered the stress and displacement around a tunnel driven in anisotropic rock mass for different anisotropic angles. The stress and displacement around the tunnel were considered for different angles of γ between Z axial directions of two coordinate systems and β between Y axes by using COMSOL software.

It is assumed that angle α between other axial directions is equal to zero. The middle vertical section of the tunnel is set as an analysis plane and center points of roof and lateral as an analysis point. In order to avoid influence of element size on the result, we used the same mesh model in every analyzing step.

The results well describe the anisotropic direction of rock material influences the stress and displacement around the tunnel. This method could be applied in studying the behaviors of other anisotropic materials.