Iranian Journal of Engineering Geology
Autumn 2018, Vol.11, No.3

Geometric Modeling of Joints in 3D Discrete Fracture Network (Case Study: Liroo Dam construction site)

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Abstract

Fluid flow behavior study is very important in many construction, mining and environmental projects. The estimation of hydraulic behavior requires a proper understanding of the hydraulic behavior of fractures and an accurate model of fracture network in rock mass. On the other hand, the uncertainty and variability in engineering geology studies in relation to masses made of natural and heterogeneous materials is inevitable. In this paper, due to the high importance of random geometric properties of joints, including orientation and persistence in hydraulic behavior of the Liero dam construction site, the network model of fractures of three-dimentional discrete fractures was developed. To this end, a code is written in the Mathemtica software called 3D-DFN. The joints of the dam foundation after surveying, drawing, separation and fitting of the best statistical distribution functions to their geometric components were modeled by three-dimensional discrete fracture networks. The prepared geometric model was validated based on the comparison of the statistics of distribution functions obtained from the output of the model with the statistics of the input distribution functions of the model. Finally, the linear, surface and volumetric joints intensities (P10, P21, and P32) were calculated from the two-dimensional longitudinal sections and three-dimensional model and then compared with the actual surveyed values. These values respectively have more than 90, 75 and 90%, adaptation with really two surveyed joints. Hence, these results can be used as a reliable input for numerical modeling of stability analysis and hydraulic analysis.

KeyWords: *Geometric modeling, Three-dimensional discrete fracture network, 3D–DFN code, Liroo dam construction site, Statistical distribution functions, Joint intensity.*

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Extended Abstract:

1. **Summary:**

The Liroo dam is one of the largest concrete dams in Iran, which is 240 meters' height and 295 meters long. The most important step in hydraulic analysis is the most realistic definition of the discontinuity network. The purpose of this study is to prepare a representative geometrical model to estimate the amount of water leakage from joints and fractures in the Liroo dam support walls and basins. The 3dimentional geometric model of the fracture networks is provided using the code written in the Mathemtica software, called 3D-DFN. Raw data gathered from surveying of rock walls after statistical process, this data used as input data to 3D-DFN code. finally Output of code compared with input data. Results demonstrate close distribution functions for geometrical parameters of joints and similar joints intensity.

2. **Introduction**

the effect of water flow in the rock mass is one of the main issues in geotechnical engineering design. The water leakage in geotechnical project, especially in dam site, is one of the most important critical factors. In jointed rock mass, main porosity is due to intersection of opened joints, in fact connected joints create fluid flow paths. This geometrical modeling has been done to increase the understanding of the hydraulic behavior of the rock mass discontinuity's system.

3. **Methodology and Approaches**

Joints survey was done at the dam support walls. Then using statistical analysis, the best distribution functions for the geometric properties of discontinuities were estimated. Considering the random characteristics of the geometric parameters of the joints and providing a more realistic model of rock mass that is statistically valid and indicative of rock mass is necessary to use in hydraulic analysis. In the modeling, using discrete fracture network algorithm (DFN), joints were considered to be finite, providing a geometric model close to real conditions than unlimited joints.

4. **Results and Conclusions**

The prepared geometric model was validated based on the comparison of the statistics of distribution functions obtained from the output of the model with the statistics of the input distribution functions of the model. Finally, the linear, surface and volumetric joints intensities (P10, P21, and P32) were calculated from the two-dimensional longitudinal sections and three-dimensional model and then compared with the actual surveyed values. These values respectively have more than 90, 75 and 90%, adaptation with really two surveyed joints. Hence, these results were used as input of a reliable geometric model for modeling the hydraulic flow into the left and right dam support walls.