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Failure process analysis of geomechanical model based on acoustic emission technique

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The acoustic emission (AE) technique is introduced to the geomechanical model test to study the failure process. A failure analysis method has been presented based on AE event positioning and AE signal fractal characteristics.

The geomechanical model is constructed with small blocks according to principles of similitude. Before masonry of the model, uniaxial tests are conducted on cylindrical specimens made of similitude material to ensure its availability. The correlation dimension is employed to evaluate the fractal characteristic and the G-P algorithm is used for calculation. The experiment demonstrates that AE fractal characteristics in the specimen failure process are similar to those of rock specimens.

After masonry, AE sensors are arranged on the geomechanical model to obtain signals during its failure process. An overload method is applied in the model to determine its safety margin. Both the time difference of AE event reception and the fractal characteristic of AE time series during the overload process are analyzed. The location of crack initiation and propagation can be ascertained roughly through 2D positioning algorithm. The weakest zone of the structure determined according to the 2D positioning algorithm has been verified through 3D numerical simulation. Besides, when the overload factor K changes, both the variation of the correlation dimension and the failure mode of the model are analyzed. The relationship between the failure process and fractal characteristics is summarized. The fractal characteristics will change sharply when large-scale cracks occur or stress state alters for the model. AE fractal characteristics are related to the overall safety of the geomechanical model, which can be confirmed by traditional stress-strain measuring devices and video monitoring system. Changes in the fractal dimension can be employed as a precursor to the cracking and failure of the geomechanical model.