MESH GENERATION OF GEOLOGICAL BODY WITH CRACK EXTENSION

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Summary Simulation of geological disaster is usually tedious and time-consuming. The meshing quality of the discrete model influences the accuracy, convergence and efficiency of the solution. Generally, the time for meshing a finite element model is often a significant portion of the time for obtaining results from finite element solution. This paper focuses on mesh generation in numerical simulation of fractured network system in geological problems. Usually initial cracks exist in such fractured network system, and new cracks will generate during deformation of geological body. The existence of cracks, especially the extension of the cracks, brings lots of troubles for mesh self-adaptation. In this paper, a meshing approach that takes mesh self-adaptation with crack extension into account is proposed, which includes: geometric data cleaning of cracks, construction of cracks, fast node inserting and triangulation, local re-meshing, and mesh quality improvement.

PRETREATMENT OF CRACKS

First, the geometric data of cracks must be analyzed and modified if necessary to ensure the applicability for mesh generation and the FE simulation [1]. Some tiny cracks are removed or merged into big ones. Then nodes along cracks are inserted in pairs in advance according to pre-defined element size. Thus the cracks are confined by these pre-setting nodes and described or constructed in some sense (see Figure 1).

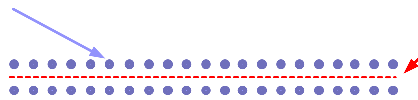

Figure 1. Inserting nodes in pairs along crack

CONSTRUCTION OF CRACKS

With the retained pre-defined nodes around the cracks, next step is to generate mesh in the whole area using fast node-by-node Delaunay inserting techniques (at this moment do not consider the recovery of the boundary to maintain cracks, see Figure 2).

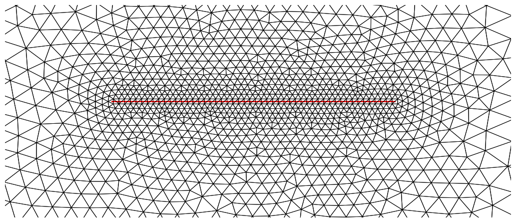

Figure 2. Triangulation by fast node-by-node Delaunay inserting

Then by clearing up and merging the mesh around cracks, cracks can be exactly constructed, and the whole mesh is completed (see Figure 3). This approach can also be used to generate inner-boundaries inside the region.

LOCAL REMESH FOR NEW CRACKS OR CRACK EXTENSION

The above approach can be used to construct initial cracks. For new created cracks or crack extension, local re-meshing technique is applicable. A local region is first taken out, and then re-generate local mesh of this region with new cracks constructed by the proposed pre-defined nodes method (Figure 4).

In order to improve the accuracy of the discretized model, mesh quality optimization techniques (Sun and Liu [2]) includes smoothing and topological optimization are performed to raise the mesh quality around cracks. The proposed approach is successfully applied to modeling of two-dimensional fractured network system in geological problems.

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Study on three-dimensional case is progressing steadily. The adaptive meshing during crack extension is worked out for a landslide problem when the plastic band is generated (Figure 5).

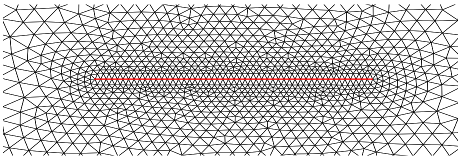

Figure 3. Mesh clearing up for crack construction

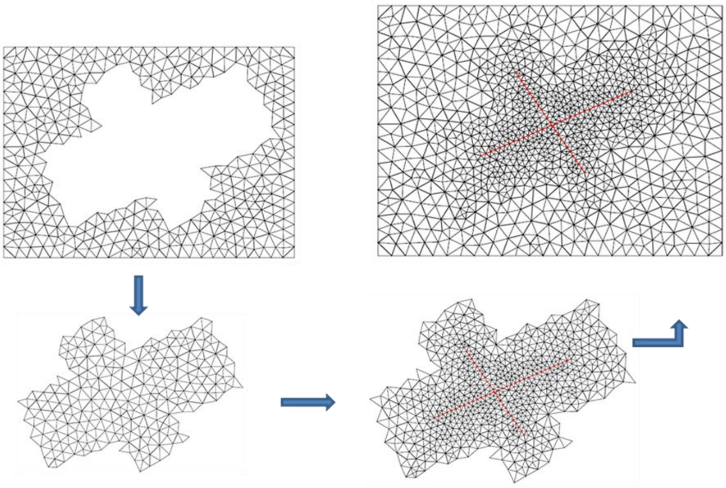

Figure 4. Local re-meshing for new created cracks or crack extension

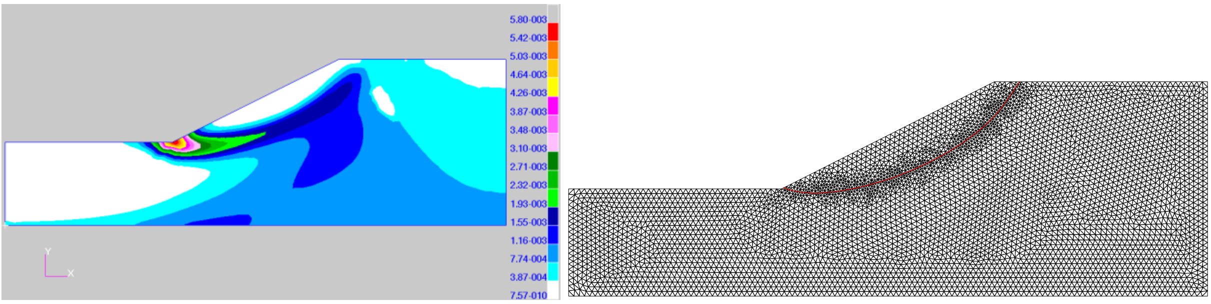

Figure 5. Plastic band and the adaptive resulting meshing during crack extension

ACKNOWLEDGEMENTS

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