◆ Model database

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Joint particles model database for discrete element numerical simulation

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Abstract: Particle flow calculation is an essential method for numerical simulation. Single spherical particles cannot meet the increasingly complex particle simulation requirements, and joint particles may simulate materials with different shapes. To ensure the consistency of simulation and actual materials, the gradation of the two materials needs to be the same. However, the premise is that the particle size of the joint particles is obtained by calculation. It is very cumbersome for researchers to form particles and calculate the particle size when calculating joint particles. This problem can be solved by building a particle database. This paper establishes this database, and parameters such as particle size and area of joint particles are calculated. It dramatically simplifies the workload of joint particle simulation personnel and can compare simulation results of different researchers, which is beneficial to the promotion of research results.

Keywords: joint particle, particle size, discrete element, database

1. Introduction

Numerical simulation methods can study the stress-strain and displacement-force properties of rock and soil mass and geological mass. The premise of numerical calculation is to establish a numerical model. The closer the selected model is to the actual geological body, the closer the mechanical calculation result is to the natural rock and soil body. Particle flow can simulate various geological bodies well, and it is a simulation method in parallel with finite elements and boundary elements.

There are single sphere, multi-sphere, and joint models for particle flow simulation. The single-sphere model simulates the situation where the particle shape is close to a circle, and the particle size is relatively uniform; the multi-model model simulates the material with the particle shape close to a circle, and the particle size is more diverse; the joint model simulates the particle body with a more complex particle shape. The particles of the real geological body materials are more complex and have different shapes, so the joint model is the future development trend.

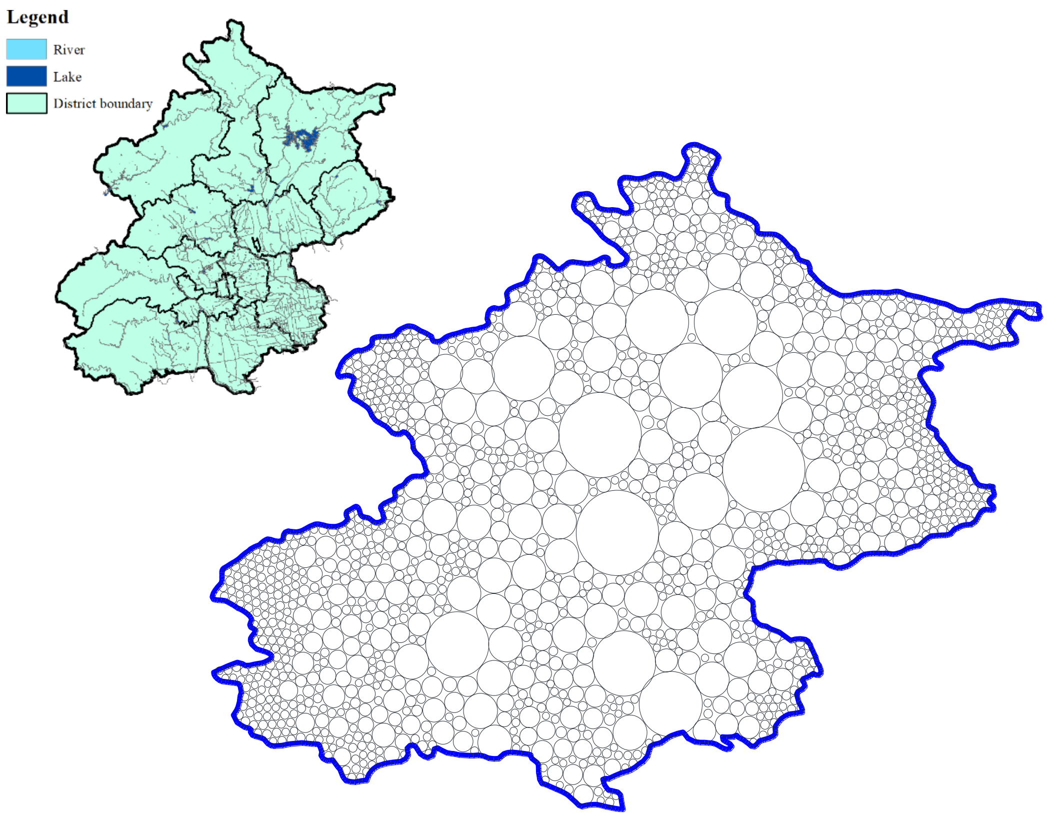

Figure 1 Beijing map and particle filling map

When performing particle simulation, how to make the simulated particle more in line with the actual particle. The satisfaction of the particle shape parameters is the first. It is now better enough to simulate a variety of complex shapes [1], as shown in Figure 1. However, ensuring the consistency between the geological bodies that need to be simulated for the composition of many joint particles has become a complex problem to be solved by the current joint model. In the paper [2], the author of this paper has solved this problem very well; through the method of rotating the model, the particle size of the joint particle is obtained, and then the gradation of a large number of joint particle model particles is obtained. The gradation curve of the simulated material is completely consistent with the gradation curve of the actual rock and soil material. The consistency of the shape parameters of the joint particle simulation material and the real geological body material is achieved.

In the actual simulation, another problem arises: different materials, such as concrete, soil, gravel, sand, and other materials, and various research fields such as geological engineering, hydraulic engineering, etc. At times, if the geometric particles are constructed step by step, and then the particle size is calculated, the whole process is very cumbersome and greatly affects the progress of the research. To this end, this paper establishes a database of joint particles, which researchers of joint particles can directly use. At the same time, different researchers can compare the calculation results well after using the same database. These comparisons are based on the same database, and the comparison of calculation results is convincing. It is convenient for the technical promotion of results.

2. Database introduction

The parameters of the joint particles include the number of circles composing the joint particles, the radius of each circle, and the particle size (width) and length of the joint particles formed. And the gradation curve of particles composed of a large number of joint particles is obtained by further calculation. And adjust the gradation according to the particles of the database [3].

Some of the particles in the particle library are shown in Figure 2. The 1995 particle in the database consists of three round particles, C(x, y, r) are C1=(6.65082 0.387705 2.84873), C2=(8.39598 1.2141 2.60592), C3=(4.0401 1.88586 2.70651), listed in In the file 1995.txt, the particle size of the joint particle is the minimum width covering the width of the rectangle, which is 6.57373. The length of the rectangle is 9.71865. The particle must be rotated 100.08 degrees counterclockwise to make the minimum width horizontal. These three values are placed In file 1995_rect_wl_angle.txt. The projected area of this joint particle was also calculated to be 48.4472, which is listed in file 1995_joint_par_area.txt.

3. Database usage

There are 2000 particles in the database. The coordinates and radius of the group of constant spherical particles corresponding to the joint particles and the length of the joint particles are reflected in the database. Some joint particles are randomly selected during particle simulation, gradation calculation is performed, and the primary gradation curve is obtained. Compare the primary gradation curve with the target gradation curve, find the gap, and select particles near the particle size to add to the particles to be configured. Continuous adjustment, and finally make the two gradation curves almost coincide. For the adjustment method of the gradation curve, please refer to Reference[3] for detailed steps.

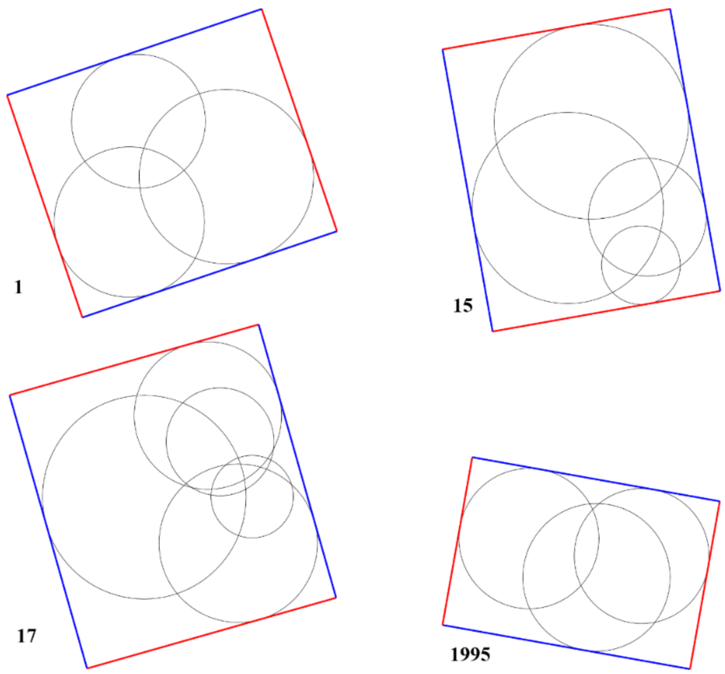

Figure 2 Several joint particles in the database

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