Effects of grain characteristics in sediment flow simulations using DEM

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ABSTRACT

To evaluate potential risks due to slope disasters, there has been a variety of numerical methods based on continuum mechanics and indeed a significant amount of research achievement have been reported in the literature. Among them, the Finite Element Method (FEM) is one of the widely-used traditional approaches to investigate the stability of slopes, but is applicable only to examine the possibility of their failure. For post-failure phenomena, Eulerian-type analysis methods have also been developed to solve sediment flow problems that are governed by Navier-Stokes equations, whereas there has been renewal of interest in Lagrangian-type flow simulation methods, called particle methods; e.g., Smoothed Particle Hydrodynamics (SPH) and Moving Particle Semi-implicit (MPS) methods. It is, however, still difficult to predict the whole process of slope disasters, since they involve complex processes of failures and flows at multi-scale levels. In order to improve the prediction accuracy for sediment flow behaviour after slope failure, we need to employ a relevant numerical method in view of accuracy, computational cost, general versatility and robustness.

The Discrete Element Method (Cundall, 1971) is known as one of the most powerful and promising numerical tools to predict granular flow problems. Although polygonal elements were mainly used when the DEM was first proposed, spherical elements are widely used nowadays because of the simplicity of associated contact algorisms. And if polygonal shapes are required in analyses, they are represented with clusters of spherical elements. Thanks to the recent development of computer powers, the DEM is becoming a more important numerical tool for risk evaluation of slope disasters. Nonetheless, it has not been revealed that how small elements and how strict correctness of shape representation are required to obtain reasonable results from the engineering viewpoints. In the present work, in order to resolve these issues, we conduct a series of numerical analyses with reference to the model test results reported in the literature (Denlinger and Iverson, 2001). Appropriate number of cases with different element sizes and shapes were prepared to investigate the effects of grain sizes and shapes. Based on the obtained results, the effects of grain shape and grain size in DEM simulations were studied to provide some useful information for sediment flow simulations in practice.

REFERENCES

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