D101

Particle Size Segregation in Bi-disperse Granular Flows: Experimental and Numerical Research

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1 Introduction

Gravity-driven narrow-channel granular flows are prevalent in natural geological hazards. Studying their movement mechanisms and disaster effects is of significant practical importance. This research employs inclined channel granular flow experiments combined with numerical discrete element method (DEM) to compare the flow and impact behaviors of bi-disperse granular flows with different size ratios.

2 Methodology

The chute experiments were conducted in an aluminum alloy inclined channel with a length of 2000 mm, a width of 50 mm, and a height of 200 mm. The side walls of the channel were made of transparent acrylic sheets, and the bottom was made of aluminum alloy, set at an angle of 32°. A schematic of the different parts of the inclined channel is shown in Figure 1-a, which includes, from top to bottom, the release section, the flow section, and the impact section. Figure 1-b depicts the impact force measurement system used in the experiment, and Figure 1-c illustrates the sensor arrangement on the rigid barrier. To better simulate the uneven substrate found in real debris flows, the bottom of the inclined channel was roughened.

The numerical simulations were conducted by Particle Flow Code 3D based on discrete element method as shown in Figure 2 which were verified by the chute experiments above. Combined with experiments and numerical simulations, the results of flow and impact behaviors of bi-disperse granular flows with different size ratios are achieved.

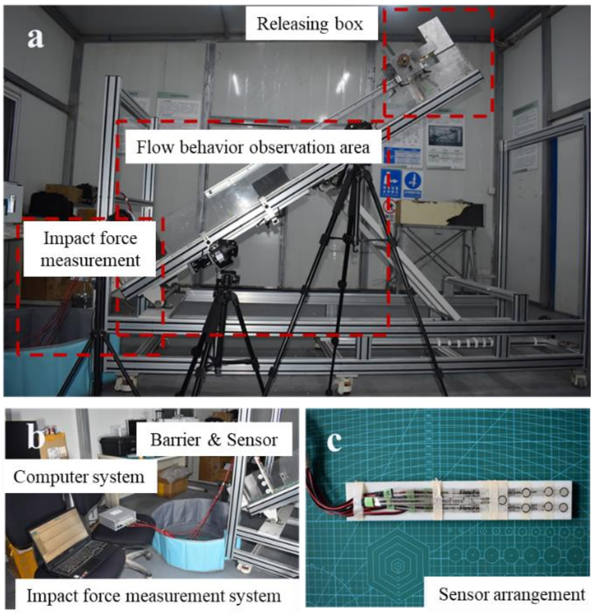

Fig 1. The experiment apparatus

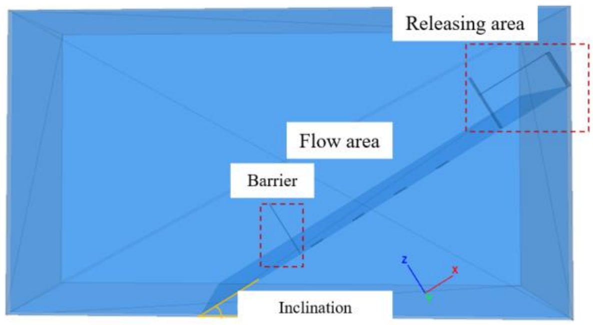

Fig 2. The numerical set-up

3 Results

Through the experimental research, the impact force of the bi-disperse system is greater (1.12 times and 1.53 times larger than that of the mono-disperse system), with a higher action position and stronger disaster causing effect.

Through the numerical simulations, the impact disaster effect of bi-disperse granular flow is positively correlated with the particle size ratio. The larger the size ratio, the greater the impact force, and the higher the position of the combined impact force

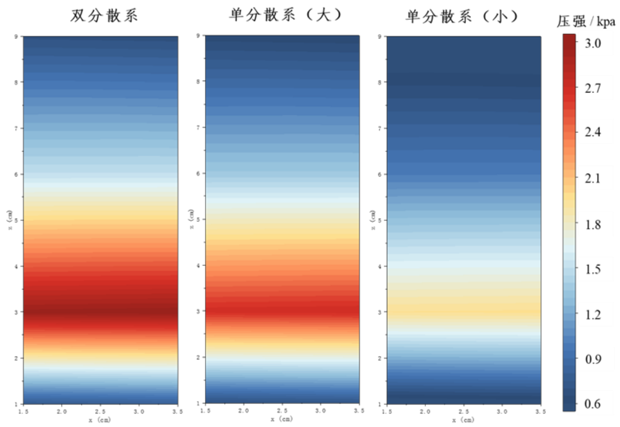

Fig 3. Pressure distribution cloud maps by chute experiments of mono and bi-disperse flows

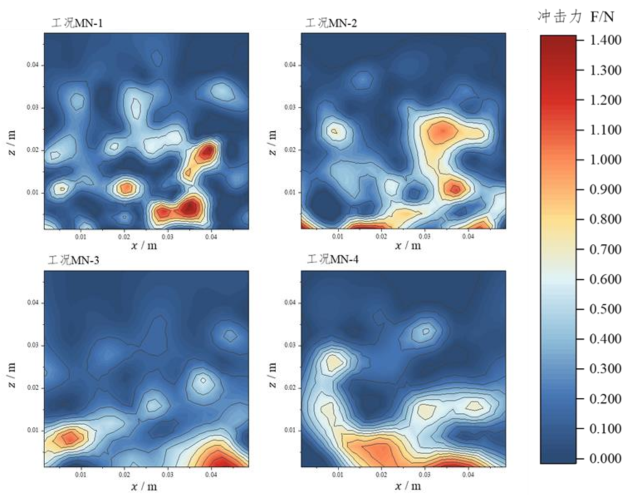

Fig 4. Pressure distribution cloud maps by numerical simulations of different size ratios

4 Conclusions

1. compared to monodisperse granular flow, the maximum impact force on rigid baffles is greater in the bi-disperse granular flow, and the combined impact force is located higher, resulting in a stronger disaster causing effect.

2. The maximum impact force of the bi-disperse granular flow with a larger size ratio on the rigid baffle is greater, the position of the combined impact force is higher, and the bending moment borne by the baffle is greater. This means that rock avalanches and slides with higher size dispersion has stronger disaster causing characteristics.

References

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