

Interactive comment on “Laboratory and Field Test and Distinct Element Analysis of Debris Flow” by Yung Ming Cheng et al.

Anonymous Referee #2

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The manuscript presents different approaches of characterizing particle flows down an incline: small-scale experiments with glass/plastic beads, large-scale experiments using granular material of sand/gravel, and the respective representation of the small-scale experiments using simulations based on Discrete Element Method (DEM) with the commercial code PFC2D. The motivation of the work is to provide an insight of the flow process and segregation of debris flows, although no consideration of fluid is present. Six types of particles have been used in the small-scale experiments, three of them are made of glass and the other three are made of plastic. 68 tests with a fixed inclination of 45 degrees have been carried with different mixtures of particles in the flowing mass: mono-disperse mixtures, mixtures with two types and also mixtures with three types, but no sensors were installed to measure flow velocities or depth. The

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main investigation was concerning the segregation process and the role of particle size and density in it. Afterwards, 2-D numerical simulations were carried out to model the effect of segregation and also the presence of a jump with two types of particles, with no mention of the contact law or governing equations. The calibration process was not shown in the paper and only qualitative comparisons with the small-scale experiments were carried out. The presence of a jump was found to slightly modify the flowing velocity, leading to dissipation of kinetic energy of the flow. Finally, large scale experiments were carried out in longer flume with granular material consisting of sand/gravel with different sizes (five samples). A long qualitative description of the results claiming that the segregation process is well present with same observations as the small-scale experiments (ex: inverse grading phenomenon). Discussions and conclusions are then presented. Some parts are written with a poor level of English which makes it hard for the reader to follow.

In order to decide on the publication of this paper in NHSS, I would like to highlight the following points:

First, the paper is titled 'debris flow', although a more appropriate name would be 'dry particle/granular flow', since no presence of fluid is considered. Such a presence would greatly influence the flow behavior and change its kinematics. The dry granular flow considered in the study, with the relatively big size of particles chosen could better resemble a rock avalanche than a debris flow. Moreover, the study focuses mainly on segregation process and effect of particle size, and this should be reflected in the title.

Second, the introduction mentions lots of statistics concerning the previous slope failures in China with no proper referencing (Lines 30-42). The same applies to the figures of previous events (e.g. Fig 1) where no reference is cited. In addition, when speaking about previous studies of debris flows, too much details are given that are unnecessary (e.g. the location of USGS flume). So many numbers are given concerning the geometry of previous flumes but no proper conclusions/open challenges of their work are presented (Lines 89-102). Previous work on modeling debris flow was detailed too

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much with no added values (see for example equations 1 and 2 which are not used in the script afterwards), especially that these models were not based on DEM, which is the core of the present paper. On DEM studies, the authors failed to present a proper scientific literature review of the previous studies on granular flows modeling with DEM, and wrote instead a brief paragraph (Lines 132-137) on that with no highlight of what still needs to be done on this subject, Especially DEM simulations of segregation process.

For the small-scale lab experiments, the description of the carried out tests lack clarity and is found to be confusing for the reader (Lines 181-203). Furthermore, the quality of the images showing snap shots of the flow process is poor with not enough brightness, which makes it hard to draw strong conclusions. In addition, very often statements are made with no solid proof or measurements (e.g. lines 240-244 and lines 256-262). Such statements could be taken as assumptions to explain certain phenomenon but not as affirmative statements. More importantly and unfortunately, the experiments were carried out with no sensors to characterize flow depth and flow velocity (flow velocity could however be back calculated from the High speed camera).

More importantly, for DEM simulations, the section starts with mentioning studies on the run out which is not in scope of the paper (lines 286 – 288). In addition, no proper presentation has been given concerning the used contact law or the governing equations. Is it purely elastic? Elasto plastic? Elasto viscoplastic?. Particles are created in the model using the 'rain method' with no description of what it means: how are particles generated and at what time/condition do authors consider the sample to be in quasi-static condition and open the gate? Moreover, authors assume that their model is calibrated only by qualitative comparison with the experimental data. Very long description of the apparent 'agreement' between the model and experiment is detailed although such agreement is hard to judge because it is only qualitative and because of the low quality of experimental images. For a calibration to be justified, a more in-depth comparison with flow velocity and depth should have been carried out between model

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and experiment. There is also no presentation of the most sensitive parameters of the model that needed calibration. Such a calibration process is crucial for the understanding of the model's results. It might be the case that same results could be obtained with more than one set of parameters. Strong arguments are presented concerning the flow regime and whether it is inertial or frictional, although no concrete measurements exist to calculate Froude number using velocity and height. In Fig 12, it is not clear which velocity is it (in flow direction, the norm of the velocity vectors .. etc). The only paragraph that is supported by quantitative measurements is in lines 400-415, although results of Fig 13 are hard to read due to its poor quality.

The large-scale experiments were also carried out with proper quantification of flow velocity and height through sensors. Authors depended on qualitative description of the segregation process which is harder to judge than the colored particles in the small-scale experiments. Authors claim that the results are similar to those of many previous studies, although it is not supported by quantifiable evidence.

The discussion part, which is supposed to take one step deeper in the analysis of results, included only a mixture of the abstract, the previously presented literature and a repetition of what has already been said in the previous section concerning the segregation phenomenon and the energy dissipating function of the jump. Claims concerning the Savage number are not supported with measurements.

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