Natural Hazards
and Earth System
Sciences

Discussions

Interactive comment on "Elasto-plastic-adhesive DEM model for simulating hillslope debris flows: cross comparison with field experiments" *by* Adel Albaba et al.

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The authors would like to sincerely thank Dr. Bruno Cagnoli for his comments on the submitted research paper.

The comparison between the numerical DEM model and the experiments concern the flowing velocity, flow height and the impact pressure that is exerted by the flow on the vertically mounted plate/sensor. The basal friction however has not been investigated in this paper due to the lack of reliable experimental details.

The effect of grain size is indeed an important factor to be considered, especially for

DEM simulations which are based on the discrete interaction between objects. As a result, different particle size values have been tested in the sensitivity study of the model and their respective effect on the flow behaviour and impact pressure have been discussed.

1) I would add grain size data about the field slurries in line 16 on pag. 4.

The grain size data is added in the revised version

2) Size and shape of the obstacles with the pressure sensors is a piece of information that must be provided. If these obstacles are not too tall with respect to the flow thickness, the recorded pressures can probably still be considered basal stresses. Is this the case? If different words are used in the text ("plate") and in Fig. 2 ("sensor"), it is not clear whether the pressure plates that have recorded the data are flush with the channel subsurface or they are those mounted on the obstacles protruding from the subsurface.

The new version of the paper will clearly state that the sensors are installed in the vertical direction to the channel base and flow direction. As such, the pressure recorded during the experiments and simulations are impact pressure in normal to the sensors. The word plate would not be used in the revised version

3) Filtering pressure data by replacing the original values with local averages (lines 29-30 pag. 4, line 1 pag. 5, lines 4-6 pag. 14) causes the loss of precious information about particle collisions. The same can be said about disregarding the data set from the smaller pressure plate (lines 14-16, pag. 10).

The authors are thankful for raising this important point concerning the filtering of DEM signal which has a direct effect on the way the maximum impact pressure is calculated and also relates to the calibration process which is partially based on the comparison between maximum pressures of DEM and Exp, in addition to the flowing height and velocity. The strong oscillations of DEM signals are usually linked to many factors

including the number of particles, the area that is being impacted, the frequency of recording data, the mean particle diameter and the number of contacts. One difficulty in the current study however is the fact that the experiment represents a full-scale hill slope debris flow with a volume of 50 m3. Such a large volume requires running simulation with particle sizes that are relatively large (d50 = 75 mm) in comparison with the range of sizes, in order to keep the total number of particles within feasible range as to the computation capabilities of the super computers (the average total number of particles is around 160,000). In addition, the sensor size is indeed small (200x200 mm) in comparison to the mean particle size considered for the simulations, which leads to having few contacts per impacting step and thus a discrete fluctuating signal in DEM. Furthermore, the possible variation of the particles' initial spatial distribution in the released material might also have a small effect on the force signal, as reported in some DEM studies (e.g. Albaba et al 2015). Because of all aforementioned reasons, there is a need to define a filtering interval based solely on an investigation of the DEM signal and independent of the experiment's filtering interval. In the revised version, the authors propose an analysis of the DEM signal based on two points: I. The repeatability of the same tests to account for initial spatial variation. II. The signal of different simulations with different parameter values.

First, the same DEM simulation would be run 10 times with different initial spatial distribution and then the maximum pressure will be plotted against different filtering intervals (0.025 s up to 0.5 s). In addition, the relative error defined as the normalised difference between two successive values of maximum impact pressure would be plotted. An optimum filtering interval would be defined as that with a relative error of 5% or lower. The same would then be carried out for the different DEM simulations with different parameters The filtering interval to be used for filtering the DEM and deducing the maximum impact pressure would be the optimal one while considering the two points above.

4) In our laboratory experiments finer grain size flow are faster than coarser ones (Cagnoli and Romano, 2012a). I therefore wonder whether the presence of an in-

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terstitial mud reduces the differential between the energy dissipation rates of flows with different grain size since you obtain virtually the same speed for them (lines 8-9, pag. 18). Unless the distance between position 2 and the release location is too small to see any difference.

The effect of the ratio of k1/k2 on the flow height and velocity was found to be limited because the variation of this ratio only concerns the interaction between the particles themselves. The interaction between flowing particles and the base of the channel is governed by a visco-elastic contact law where the value of epsilon_n was fixed based on previous studies of Albaba et al (2015). In that study, it was shown that the flow height is affected by the value of restitution coefficient while the flow velocity is governed by the value of the microscopic friction angle. All these details will be presented in detail in the new version.

5) Concerning the negative pressure values visible in Fig. 22 on pag. 23, are they artifacts due to pressure plate oscillations after collisions with the rock fragments?

The negative pressure values are artifacts of the sensor used in the experiments of Bungion et al 2012.

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