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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Model development for simulating mudslide and the case study of the failure of the gypsum tailings dam in East Texas in 1966" *by* Tso-Ren Wu et al.

Anonymous Referee #1

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General Comments:

In this paper, the authors use the Navier-Stokes-type equations to describe the mud motion with a PLIC VOF code to track the mud surface. This is primarily achieved by modifing the conventional Bi-viscosity model by incorporating the rheology relationship between the solid-type and liquid-type state of the material. A yield strain rate is used to identify the plug and liquefied regime. Some validations of the model are presented with analytical solutions and laboratory experimental data. Furthermore, a case study of the failure of the gypsum tailings dam in East Texas in 1966 is provided. And, a series of sensitivity analyses on the yield strain rate and grid resolution are

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Discussion paper

presented. From numerical/simulation point of view the results are interesting as they capture some basic observed phenomena, the audience of NHESS might find it useful. However, the physical and mechanical aspects of the manuscript are weak, and could be substantially improved. Writing is often very strange and less scientific/professional. I would suggest to take help from a professional English editor. Referencing of relevant, recent literature could be improved.

Title: I don't see much of the model development, rather simulations. So, I would suggest to remove "Model development for" from the Title. If not, please justify why you want to keep it.

Abstract: Abstract needs to be substantially improved/re-written, here are some examples.

"Mudslides, avalanches, and mine dam-breaks can be serious disasters and cause severe damages but the detailed flow field description has not been completed yet.": This is not true, at least for avalanche, mud and debris flows, see, e.g., Mergili et al., 2020 (https://doi.org/10.5194/nhess-20-505-2020; https://doi.org/10.5194/hess-24-93-2020); Yu et al., 2020 (https://doi.org/10.5194/nhess-20-727-2020). There are too may acronyms in the abstract, making it difficult to follow/remember. "a yield strain rate is used to identify the plug and liquefied rheological prosperities. The viscosity term is solved by implicit iteration.": Do you need to say these in the abstract? "The slip surface is developed automatically without empirical equations.": What does it mean? "By comparing the results of BM, CBM, and MBM to the field data, we conclude that the liquefied tailings are under the effect of stratification, and the stratification effect is presented in the extremely high plug viscosity in the Splash3D model.": Isn't it meaningless as far as you are talking about the superiority of MBM?

Specific Comments/Technical Improvements:

L23: Provide References, also in the following text whenever necessary.

L26-28: “the information is not complete”: what do you want to say, not clear. “one-dimensional profiles”: of what? “contradictory”: with what? Please make these aspects clear.

L32: –> (means you may consider to include, or change to): or the Coulomb-viscoplastic model (Pudasaini and Mergili, 2019: https://doi.org/10.1029/2019JF005204).

“Both of Bingham model and Herschel–Bulkley models’ ideal are discontinuous”: please check English. I would suggest to take help from a professional English editor.

L46: –> Recently Pudasaini and Mergili (2019) proposed a first-ever multi-mechanical, multi-phase mass flows model that employs pressure- and rate-dependent Coulomb-viscoplastic rheology that is very flexible to be applied to the wide range of geophysical mass flows.

L51: “with strong vertical fluid particle acceleration.” –> “with strong vertical fluid particle acceleration (Domnik et al., 2013: https://doi.org/10.1016/j.jnnfm.2012.03.001, https://doi.org/10.1016/j.jnnfm.2013.07.005).”

L54: “stress” –> “stress (von Boetticher et al., 2016, 2017: http://dx.doi.org/10.5194/gmd-9-2909-2016; https://www.geosci-model-dev.net/10/3963/2017/; Domnik et al., 2013; Khattri and Pudasaini, 2019: https://doi.org/10.1016/j.matcom.2019.03.014)”

L55-60: Please improve writing.

L74: –> and multi-phase mass flow (Pudasaini and Mergili, 2019)

L74-82: Very basic, could be removed.

L82: “However, Navier-Stokes equations derived under the assumption of Eulerian fails in describing the solid motion.”: What does it mean? Not clear.

L86-89: Please explain how you would obtain stratification, because this is the main aspect of this MS. And, it seems to be mostly parameter fit, increase mu_A as high as you get what you want. So, what is the mechanical aspect of this paper, and how can you justify using those mu_A values. This is a critical aspect here. Please clearly justify, discuss.

L87: –> but, this could be regularized (Papanastasiou, 1987: https://doi.org/10.1122/1.549926; Domnik et al., 2013; Pudasaini and Mergili, 2019; Yu et al., 2020).

L95-101: Can you include the effect of particle concentration in the slurry viscosity as in von Boetticher et al. (2016)? Which value of mu_A would be chosen, how/why and are there any experimental/field evidence? Please discuss. Also write explicit expression for "dot(gamma):dot(gamma)", helping the reader. Does (3) avoid discontinuity, or increase it? Consideration of (3) does not seem to constitute a new model as mentioned in the Title. This appears to be defined for simulation purpose to try to obtain pattern seen in the field event. If not, please provide arguments.

L108: It is a bit confusing. Sometime you talk about solid sometime about fluid, and now it appears that the material is dry. What type of material, and composition is considered? Further, how do you determine r? As the material density changes during motion, do you have a transport equation for r? The VOF method was also used by Yu et al. (2020) to track the interface between the tailings and air. Also, improve English in the following lines.

L116-125: (i) It is not clear if you are using (6) and (7), or only (8). (ii) If (6) and (7) are used what is the advantage? (iii) Can you provide some references? Or, do you develop all these equations (3)-(11)? The readers would wonder. (iv) Can you define what is solid and fluid? It is completely confusing. You mention sediment and fluid, but never mention what material/composition you are considering. Are you using solid + fluid two-phase mixture material? Does not seem so.

L138: “a large viscosity parameter is imposed”: again, no physical explanation.

L158-159: Could be removed, not necessary, very basic.

Table 1 is not needed, all parameters are in Fig.

L176: “Because of the yield stress, the free surface parallels to the plane bed”: But not in the front.

L177: “The mud front, just like a steady gravity current, eventually advances at a constant speed”: Can you show it analytically, or you are talking only about numerical results?

L190: “lateral boundaries (y = 0 m and y = 400 m) are free-slip boundary”: Strange! Why don’t you explain why this condition is used while the base is no-slip?

L193: The value of mu_A is huge! Can you justify it mechanically, or prove with evidence as the paper is mainly based on such values?

L196: “Splash3D”: Please explain it briefly, not all the readers might know it.

L211-215: The most important aspect of this paper is concerned with the generation of the stratification pattern observed in the field event. However, the authors could not make it quite clear what exactly is the mechanism in their model that produces these patterns. This is perhaps the major drawback of the MS. How can just gravity do that job? Please make it clear.

L222-223: “the simulated mudflow by using MBM can go further because the yield strain rate limits the velocity at the initial stage”: this is great! Seems to be the best thing in the paper!

L232-233, 250-252: “Not only freezing time, and mean velocity but also the value of inundation distance receives good agreements with observed values.”, “the MBM result takes a longer time to reach the zero-velocity stage and the resulting inundation distance is longer than the BM result.”: This is very good! However, not yet clear which

mechanism produces the real pattern. And the pattern seen in the simulation is very weak as compared with the real field event. Please discuss.

L254-255. “The sliding slope of the mudslide is developed automatically by MBM. This is big progress in studying mudslide flows.”: No! This slope is also seen in BM. So, not clear what you want to say.

L314: References: Improve including suggested.

Fig. 4: Interchange panel a and b.

Fig. 6: panel d very basic, and e is in Fig. 7. So, you could remove these panels.

Fig. 7: “liquefied tailings” –> “deposited tailings”. Local elevation changes in b (field photo) is very strong, however in a (simulation) it is very weak. Explain, and try to improve.

Fig. 9: Panel with time = 30 s: Not the same time, and not the geometry, this is somehow similar to the real geometric pattern in Fig. 7 b. I would expect to see similar pattern of the final geometry.

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