# Review of manuscript NHESS-2022-173 – revised version

## Sensitivity analysis of a built environment exposed to debris flow impacts with 3-D numerical simulations.

## Overview

I appreciate how the authors modify the manuscript and try to answer all the questions proposed by the Reviewers in their comments. However, some questions remain still open while others arise from the revised version of the paper.

## Observations and questions

In the following, all the questions and observations arose from the reading of the new version of the manuscript.

1. I know very well that the longer the simulation, the longer the time used and the bigger the amount of f data to be analysed, but I think it is not entirely acceptable that all the analysis is developed with a limited time for the evaluation of the maximum peak impact force. As mentioned in [RC1] and [RC3] for all the two cases in which the time variation of the impact force is reported (so Figure 17 and Figure 21) the force trend is still increasing at the end of the plot (simulation) and some maximum values are evaluated exactly at the end. Additionally, some intersections between the impact force are present depending on the variable analysed. This means that if the simulation is longer than the used 10s and since the maximum values can increase, it can happen that also the analysis of the variable involved can change giving rise to a modification of the effect: by way of example only, it can happen that if the simulation is longer, the peak impact force of the case Or30-Op0-Anull-Dnull becomes greater than Or0-Op0-Anull-Dnull so all the discussion provided by the author present a limited scientific meaning. This means that lines 172-174 were not sufficient as an explanation for the time length, nor the statement that a longer simulation requires too much time).
   I suggest that in at least one of the tests where the time variability of the impact force is plotted, the authors produce longer simulation (for example, as suggested in [RC3] "*increase the time of the simulation until a significant (a few seconds?) decreasing, or at least constant, value of the impact force is visible*") in order to show that the used value produce something that has real scientific relevance. I think that providing this for at least one involved variable will demonstrate that the peak impact force values used are trustworthy.
2. The title can be misleading. The paper tackle <u>monophasic viscous</u> debris flow with a (very) <u>synthetic</u> and simplified hydrograph. I think that the underline words, or their meaning, must appear in the title. These concepts must appear also in the Abstract.
3. Line 12: "peak impact forces" -> It is not completely true since is the value obtained by a limited-time simulation of 10s.
4. Line 105: "transport equations" -> It is formally correct to say that equations (1) and (2) are the transport equation of the RNG k-ε model. However, some readers used to deal with sediment moving over the fixed bed and/or flow tracers (e.g., chemical components advected by a flow field) can be confused. I think it is better to say that the equations describe the turbulent kinetic energy ($k_T$) and the turbulence dissipation ($\varepsilon_T$) balance equations of the RNG k-ε model
5. Line 147 "perfectly" -> If the numerical model perfectly reproduces something, no difference with experimental results must be present and this is not the case. Please modify.
6. Lines 162-164 -> The authors describe the values used for the roughness of the inclined plane where the viscus debris flow moves, but what about the building? Are they without roughness, so are they treated

as smooth surfaces? Please justify the choice. Moreover, it is missing the roughness used in the model validation.

7. Lines 167-174 -> From the text it seems that the discharge, that feeds the computational domain, is considered constant and equal to 500 $m^3/s$ for all the duration of the simulations (the authors wrote on lines 168-169 "*an inflow with a time-invariance discharge of 500 $m^3$ $s^{-1}$*" and on lines 173-174 "*in the computation time of 10 s under a fixed discharge of 500 $m^3$ $s^{-1}$*"). However, in the response to the reviewer, the authors highlighted that "*In this study, the time of 10 s was not referred to the duration of debris flow hydrograph, but the computation time in FLOW-3D, that was 10 s after the debris flow was released from the inflow point*" that seems something completely different from the previous statement. From this answer, I understand that the simulation time is 10 s, but the discharge of 500 $m^3$ $s^{-1}$ has a duration completely different and it seems also that this discharge occurs only for a few time steps (or only in the first one). Please clarify this aspect because it is fundamental for understanding the work: the general meaning of the work is completely different if the discharge lasts for 10s or for only some time steps.
8. Lines 182-187 -> For me it is not fully clear how the wall dimension can be 0.35m. If I understand well the text, the domain associated with the building is discretized with cells of 0.25m (that is half the size of the cell used in the rest of the computational domain). But if the dimension of the building cells is 0.25m, how is it possible to have a wall dimension of 0.35m? Is the 0.35m value an average value between the different configurations (I understand that the cell could not rotate, so in certain cases, the wall is discretized by, for example, 2 cells)? Or is there present some numerical procedure that can subdivide the building cells into fractions? Please clarify this point.