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Natural Hazards and Earth System Sciences
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Discussions

Interactive comment on "Quantifying lahar damage using numerical modelling" *by* S. R. Mead et al.

Anonymous Referee #2

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Description

In this paper, the authors try to estimate the impact of lahars on buildings, with application to the city of Arequipa, Peru. The study is carried out by using numerical simulations of lahars under different hypotheses (Newtonian regime, hyperconcentrated flow, or debris flow). The simulations are based on the SPH technique. The authors indicate that the main hazard is related to the bending of the building walls due to the normal force exerted by the lahar.

Main comment

The authors identify that both hydrostatic and hydrodynamic forces contribute to the bending moment (and eventually the collapse) of the walls of a building. The former is related to the flow depth whereas the latter is related to its momentum. For describing the momentum transported by the lahar, the authors introduce the concept of "dynamic pressure", defined by the authors as ρv^2 (see line 294), and describe the components of the force as "directional components of dynamic pressure" (see eg: line 305). Although, I agree with the adopted phylosophy, I suggest to slightly modify the used nomenclature. In fact, the "dynamic pressure", is usually defined as $1/2\rho v^2$ and it is a scalar. It is used in the context of the Bernoulli theorem for describing the variations of the fluid pressure along a streamline. I propose that, the author adopt the concept of flux of momentum, which is a tensor defined as (see eg: Landau and Lifshitz, 1959):

$$\Pi = P\mathbf{n} + \rho\mathbf{v}(\mathbf{v}\cdot\mathbf{n}) \qquad (1)$$

where ρ is the density of the fluid, $\mathbf{n}$ is the unitary vector normal to a surface, and $\mathbf{v}$ is the flow velocity. Considering a surface normal to the flow (parallel to $\mathbf{n}$), the component of the flux of momentum perpendicular the surface becomes $P + \rho v^2$, whereas when the velocity of the fluid is parallel to the surface, the only component of the flux of momentum perpendicular to the surface is P. The flux of momentum is related to the force exerted by a wall to deviate or stop the flow.

Minor corrections

- In equation (1), b is referred as the thickness of the bricks used in the wall (see line 145). Later, at line 147, b is referred as the wall thickness. This is different for walls with a thickness greater that the width of a single brick. Do you consider only walls made of a single layer of bricks?

- Line 149: In this context, I suggest to specify that the “normal forces” are vertical forces.
- Line 170: Symbol $a \mapsto a_v$
- Line 190: “The critical height”. Do you mean “The critical depth”?
- Line 223: Usually the coefficient μ (eq.7) is defined “viscosity” only when the exponent m is equal to 1.
- Line 252: “equation 3”. Perhaps you mean eq. (7) or (8)?
- Lines 256 and 262: “equation 4”? Perhaps eq.(7)? Please check.
- Line 305: The “directional components of the dynamic pressure ...”. Pressure, and dynamic pressure are scalars (see above).
- Lines 315-323: Please check if the concepts of “normal stress” is more appropriate than “normal pressure component”.
- Line 437: contribution number “XXX”, please provide the number if necessary.

References

Landau, L. D. and Lifshitz, E. M.: Fluid Mechanics, vol. 6, Pergamon Press, 1st ed. edn., 1959.

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