Quantifying the vulnerability of buildings exposed to the risk of debris flows and flash floods by numerical modelling

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1.Introduction

Lahars are gravitational flows of sediment and water, originating from volcanoes.The city of Arequipa (Peru) is our case study, which is located 17 km of the summit of the El Misti volcano. Arequipa is exposed to many natural hazards, especially volcano related hazards such as high rainfall and volcanic ash that form lahars. This city includes poor populations and the structures are made of rudimentary masonry and suffers from disorderly and poorly planned growth, therefore vulnerability measurement is needed to map risks.

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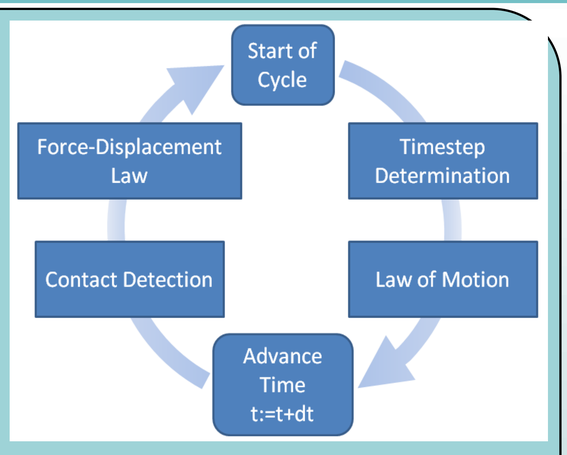
2.Objectifs

1. Propose a lahar modeling that better describes the effect of blocks.
2. Model the lahars interaction with typical structures (residential/infra).
3. Assess the vulnerability of its structures.

3.Methods

Numerical approach is used to model the impact of boulders generated by the flows on structures:

- ✓ Distinct element method **(DEM)** : allows to model a set of particles without any limitations in terms of rotations, displacements or large deformations .
- ✓ Software used : ***PFC3D*** *(to model solid phase of the flow-spherical particles)* **+** ***FLAC3D***(Darcy model shows fluid flow in a porous media in order to compute the orientation of the fluid velocity vectors in the channel) .



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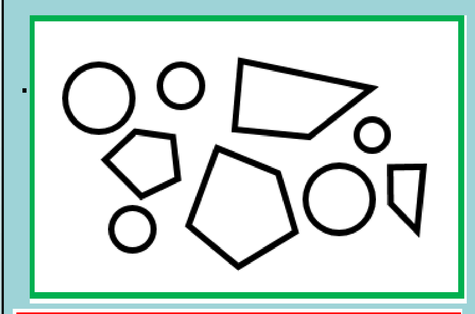
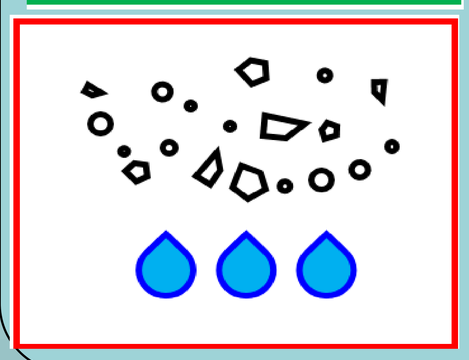


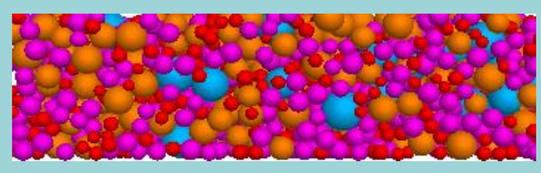


Blocks | **Explicitly modelled by *PFC-DEM***

Coupling

Water + Fines | **Modeling of the fluid and/or its effects by *FLAC3D***

Spherical particles



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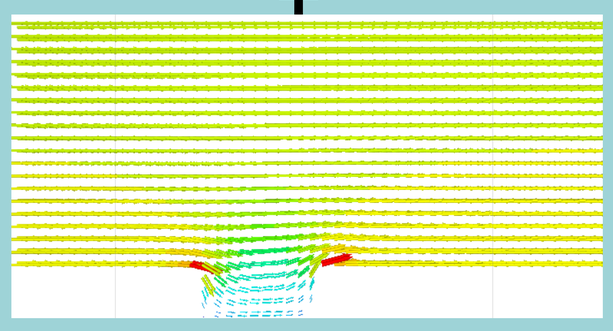
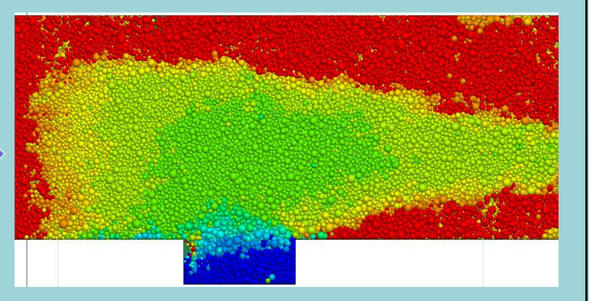


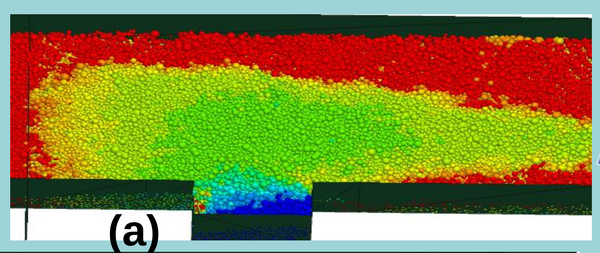
Velocity vectors



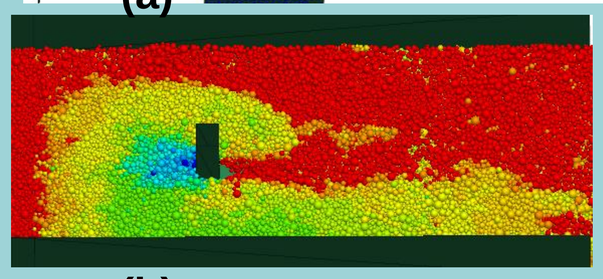
Simulated flow in the channel

4.Results

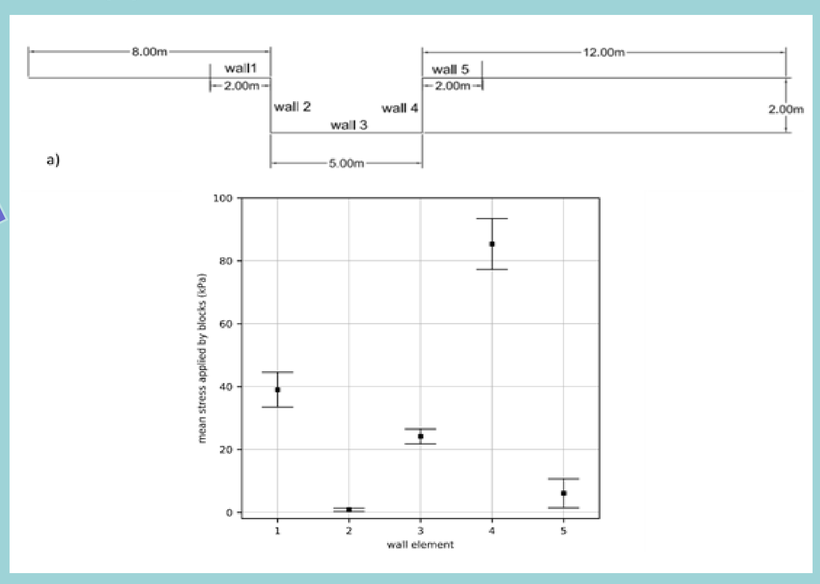
The impact stresses induced by the blocks can be measured during the simulation : (a) on wall element located along the flow path or (b) on the obstacle located in the middle of the channel .



(a)



(b)



5. Conclusion

A numerical model of debris flows is developed and validated in order to find the desired flow corresponding to Arequipa. One the flow is modelled, the forces induced by the blocks on the structure can be measured and can be added to the effect of the fluid phase. Then, total impact pressure can be used to assess the vulnerability of structures.

Bibliography

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