The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

A Finite Element formulation for pyroclastic flow simulations

Andrea Montanino[1,*], Alessandro Franci[2], Riccardo Rossi[2], and Giulio Zuccaro[1]

[1] Department of Structures for Engineering and Architecture, University of Naples "Federico II", Via Claudio 21, 80125, Naples (ITALY)
{andrea.montanino, zuccaro}@unina.it
[2] International Centre for Numerical Methods in Engineering, Carrer del Gran Capità, 08034 Barcelona (SPAIN)
falessandro@cimne.upc.edu

Keywords: *Pyroclastic flows, multiphase flows, Variational Multiscale methods*

The numerical modeling of compressible multiphase flows is of high interest for several engineering applications. In this work, we focus on the study of pyroclastic flows arising from volcanic eruptive events. An accurate evaluation of the effects of this multiphase flow is of crucial importance for institutions having in charge the development of instruments for the mitigation of the risk associated to such events [1].

In this work, we propose a Finite Element formulation for the simulation of pyroclastic flows at conditions of thermal and kinetic equilibrium. The governing equations configure an advection dominated problem, which is known to suffer from numerical instabilities. The required stabilization is provided by using a Variational Multiscale Method, typically adopted for monophase compressible flows [2], and here extended to multiphase flows [3].

The stabilized formulation is validated against benchmark problems, both in the monophase and multiphase cases. Moreover, the numerical formulation is applied to the simulation of representative cases of pyroclastic flows considering large-scale computational domains and realistic material properties and initial thermal-kinematic conditions.

The numerical analyses presented show the accuracy of the proposed method for the simulation of compressible multiphase flows and its suitability for risk assessment studies of urban settlements prone to be affected by pyroclastic gravity currents.

REFERENCES

[1] Zuccaro, Giulio and Daniela De Gregorio, *Impact assessments in volcanic areas-the Vesuvius and Campi Flegrei cases studies*, Ann. Geophys. **62**, (2019)

[2] Bayona Roa, Camilo Andrés, et al., *Variational multi-scale finite element approximation of the compressible Navier-Stokes equations*, International Journal for Numerical Methods for Heat Fluid Flow (2016)

[3] Montanino, Andrea, et al. *Finite element formulation for compressible multiphase flows and its application to pyroclastic gravity currents.* Journal of Computational Physics (2021)