Analysis of resistance of openings to Pyroclastic Flows

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Abstract

During an explosive volcanic eruption, constructions are hit by various inertial or surface actions often associated with high temperatures, that can cause fires and/or explosions that can affect the mechanical properties of structural and non-structural elements. Among the volcanic phenomena the pyroclastic flows have a devastating effect. They are a gas-solid mixture, which can flow slope down up to reach considerable distances from the point of emission, a speed that can easily exceed 100km/h (~ 30m/s) (Esposti Ongato et al, 2008). Their temperatures may be higher than 500°C and they cause serious respiratory problems. The action exerted by pyroclastic flows on buildings is a dynamic pressure accompanied by high temperatures. The experience of the eruption in Montserrat in 1997 has shown that the openings of buildings are particularly vulnerable to the stresses caused by pyroclastic flows, even when the static nature of the building itself is not compromised, the risk associated with the passage of the flow in the internal environments following the breakthrough of the openings is therefore significant, increasing the risk of fire inside the building. The damage caused by the impact of pyroclastic flows on buildings depends on the combination of several factors: the duration of the phenomenon, the temperature of the flow and the pressure produced by the impact (Spence et al, 2004). In this work, the objective is to determine the resistance of the characteristic openings of buildings potentially at risk along the flow path, considering the dynamic pressures and temperature ranges associated with a specific scenario at Vesuvius and the Campi Flegrei, defined in the Emergency Plans. The static and thermal analyses of the opening models were analysed through finite element analysis, using the Comsol code, and the results were compared with those of mechanical and thermal tests, obtained through an ad hoc test. In addition, fluid-structure analyses were also carried out, considering the flow as incompressible single-phase fluid and applying the Reynolds Averaged Navier-Stokes (RANS) turbulent model. Finally, the study aims to identify guidelines for the design of demonstration projects and prototype components for the creation of new industrial products for the building envelope, aimed at reducing volcanic vulnerability, and respond to energy and environmental principles. (Zuccaro and Leone, 2012)

References

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