International Journal of Fluid Mechanics & Machinery– IJFMM
Volume 1 : Issue 3 [ISSN 2374-1481]
Publication Date : 30 September,2014

Fluid dynamics of brittle collapse

Domenico M. Doronzo[1,*]

[1]Dipartimento di Meccanica, Matematica e Management, Politecnico di Bari, Bari, Italy

When a skyscraper collapses to the ground, the coarsest fragments are rapidly deposited close to the impact zone, whereas the finest counterpart is loaded in a fast and unsteady turbulent flow. Similarly in nature, collapses of volcanic columns, and entire sectors of explosive volcanoes generate thick deposits of coarse material at impact with the ground, instead the fine material is suspended from there on over the landscape to be re-deposited far away in thin deposits. The videos of the spectacular controlled demolitions of hotels and casinos performed at Las Vegas (Nevada, USA) in the recent past definitely reveal the collapse fluid physics of fragmented material. The fragmentation, which is necessary for such a collapse, can make a solid or granular column to powder particles of the size of natural clay or volcanic ash. These particles are mainly transported in suspension by the turbulent flow that is triggered after collapse. The phenomenon of fragmentation is characteristic of artificial brittle material, such as building concrete and cement, as well as of natural material, such as rhyolitic and basaltic volcanic magma. Here, the two aspects of fragmentation and collapse are combined in order to solve for the macroscopic fluid dynamics of brittle collapse. In particular, the similarity between volcanic collapses and the tragic collapse of the World Trade Center (New York, USA) is proposed because the spatial scale of the two events, which is of several hundreds of meters, is comparable. In terms of shedding light on the natural phenomena, the event of September 11, 2001 can be considered as a reference case, in which the fragmentation of a skyscraper, and the subsequent propagation of the turbulent flow are fully documented. The ground flow of September 11 was fluid dynamically generated in a way similar to the volcanic flow that occurred in May 18, 1980 explosive eruption of Mount St. Helens (Washington, USA). During the volcanic explosion, an entire sector of the volcano collapsed, then a highly mobile, multiphase (gas-pyroclast fragments) and turbulent flow followed, and heavily interacted with the surrounding landscape. The goals here are those of verifying, by means of numerical simulations in the context of computational fluid dynamics, whether or not a physics analogy can be drawn between brittle volcanic and skyscraper, or more generally natural and artificial collapse, by showing numerical results of the flow dynamic pressure, and fragment and dust dispersion and accumulation on the ground for the World Trade Center case.