Geophysical Research Abstracts,
Vol. 11, EGU2009-13510, 2009
EGU General Assembly 2009

Magnitude estimation and runout analysis of a rockslide for the construction of a defensive structure

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In the past few years the Maiolica (micritic limestone) quarry of Torgiovannetto (Perugia, Italy) has suffered an increasing amount of rockfalls. The rock mass has loosened progressively and a perimetral crack longer than 100 meters has appeared. The huge block bounded by this crack, two lateral discontinuities and a stratigraphic layer, threatens two roads at the base of the slope.
Since these are very important and busy traffic routes the Department of Earth Sciences of the University of Firenze performed magnitude estimations and runout analyses regarding two different aspects: 1) investigate the trajectories of single falling blocks and; 2) forecast the runout distance and the debris intensity distribution in case a large rockslide occurs.
The magnitude of a landslide is, actually, the most important input parameter for correctly estimating the trajectory, the runout distance and the kinetic energy of a landslide. A detailed and updated knowledge of the actual morphological conditions is a good starting point for defining as accurately as possible the extent of a moving block. Due to the very high urgency and precision required, a detailed survey of the quarry area has been performed by means of a High Accuracy & Long Range 3D laser scanner (RIEGLE, LMS-Z.420i). In order to avoid shadow zones and to obtain a comprehensive digital elevation model of the quarry area, a total of more than 30 million points were taken from three different scan positions. The resulting point cloud was dense enough to reveal the main structural features of the rock mass, including the discontinuities bounding the moving block, which has a calculated volume of 180 000 m3.
With the aim of confirming the block volume and assessing the deformational field of the moving mass, a multitemporal ground-based interferometric SAR survey was performed. The results of the survey precisely confirm the geometry of the unstable block and also indicate that the displacements decrease from E to W, due to the greater lateral friction in the western portion of the wedge.
This deformational behaviour has been confirmed by a wireless real time monitoring system installed for the time of failure forecast.
Laboratory tests and stability analyses of the unstable wedge allowed us to hypothesize a sudden and brittle failure behavior, which can be associated to a long runout distance.
Both empirical (energy line approach) and numerical methods (DAN-W and DAN3D softwares) were employed for estimating the runout distance and debris intensity distribution associated with the failure of the main block. The results of this analysis indicate that the potential rockslide will likely reach the nearest road.
The estimated velocity, debris depth, and kinetic energy of the moving mass can be used to project defensive structures at the base of the artificial slope.