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Safety evaluation for the "Lodovica" road following rockfalls from Sesto di Moriano quarry (Lucca, Italy)

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On October 28th 2004 a rockfall took place next to the northern limit of the limestone quarry called "Bertolucci e Fiore", near Sesto di Moriano, Lucca, Italy. After this main event, some minor rockfalls developed in the quarry in the following days, with a total volume of more than 30000 m^3.

Due to unloading effects the rock mass around the detachment zone was heavily fractured, with several huge blocks hanging in unstable conditions and threatening the road called Lodovica, which is located immediately downslope from the quarry area.

Since this is a very important route, with heavy traffic, we carried out investigations to assess the safety conditions of the road; the investigations involved the following steps:

1) Field trips to evaluate the extent of the unstable area, the volume of the involved material, and to recognize the failure or detachment mechanisms of the rock mass.

2) Execution of a high resolution digital elevation model (DEM) of the rock face and the quarry floor with the employment of a High Accuracy and long range 3D laser scanner. This technique allowed us to define the overall morphology of the area and the mean and maximum size of the rock blocks, with very high detail and very quickly, to satisfy the state of emergency. A total of more than 2 million points were acquired and the noise effect due to vegetation has been removed.

3) In situ rockfall simulations to evaluate rockfall runout, velocity and bounce height and to estimate the coefficients of restitution.

4) 2D numerical simulations of rockfalls along 5 profiles derived from the new topography, were performed by using two different methods (lumped mass and Col-

orado Rockfall Simulation Program) in order to forecast the runout, the velocities, the bounce heights and the possible impact energy on the defence barrier. The employment of these methods allowed us to confront the two possible scenarios arising from in situ observations:

a) Lumped mass analysis of fall of blocks of about 5000 kg with a predominantly bouncing mechanism, originating from the fragmentation of larger boulders;

b) CRSP analysis of motion of blocks of about 25000 kg with a prevailing rolling mechanism and limited fragmentation.

Based on numerical and in situ simulations, blocks were expected to collide with significant energy against the defence barrier only at its northern limit.

After the critical section of the barrier was strengthened it was possible to assess that the risk for the “Lodovica” road was sufficiently low, and the road was again opened to traffic on December 24th, 2004.