Collapse in a rock massif induced by lateral confinement loss: the case of Montegolf (Málaga, Spain)

J.M. Azañón (1,2), E. Puertas (3), C. Ureña (1), R. Gallego (3), and F. Romero-Gómez (4)

(1) Departamento de Geodinámica, Universidad de Granada. Granada, Spain (jazanon@ugr.es; cgunieto@ugr.es), (2) Instituto Andaluz de Ciencias de la Tierra (CSIC-UGR). Granada, Spain (jazanon@ugr.es), (3) Dpto. de Mecánica de Estructuras e Ingeniería Hidráulica. Universidad de Granada. Granada. Spain (epuertas@ugr.es; gallego@ugr.es), (4) Dpto. Arquitectura de Computadores, Universidad de Málaga, Málaga. Spain (felipe_ac@uma.es)

The use of computing codes allowing finite elements analysis is a very useful tool in detecting variations of the tensional state of rock massifs. Most of the codes used for ground modelling only allow 2D analysis. However, in the case of complex slope instabilities, it is necessary to consider the variation of resistant properties in a 3D model.

This work presents an example in which 3D analysis carried out by finite elements methods becomes essential to understand the surface processes occurred in a urbanized rock massif (Montegolf, Malaga). The studied area is a small hill of elliptical shaped plan (300x200m plan). As a main peculiarity of this hill, it was intensively undergone to human activity in recent years. On September 11th, 2000, the collapse of an inner cavity (100m3 in volume) took place. The cavity proceeded from a mining abandoned 30 years before. The application of a 3D finite elements model showed that the highway slope digged in the Eastern face of the mount produced a change in the tensional state inside the mount. Vertical stresses shifted from compression to tension eliminating the vault effect.

To define the geometry of the model, a survey of the existing contour map was carried out and conveniently transformed into ACIS format to be processed by ABAQUS (finite elements program). In the two-dimensional case an E-W section involving houses, highway and cavity was chosen. Mining hole was considered in the model, using a 10m-diameter sphere to represent the cavity. The performance of the natural materials was supposed to be elastic so Young modulus and Poisson's ratio were required.

The ground strains due to collapse of the cavity and obtained by the finite elements model were accurately related to the mapping of cracks on the surface, the sinking of topographical landmarks (located on the top of the mountain) and the photographic analysis (captures before and after the collapse). Thus it is confirmed that the surface sliding which affected the residential house Montegolf was caused by the collapse of a cavity inside the mount. 3D models confirmed that the highway slope digged on the mount and the subsequent instabilities in that slope were the main conditioning factors of this collapse.