ABSTRACT

Borela Valente, Rodrigo. M.S.C.E., Purdue University, August 2016. Stochastic Analysis of Subsidence Due To Underground Activity. Major Professor: Philippe Bourdeau.

Many communities around the world have been established in areas of ongoing, as well as ceased, mining activity. Ground movements induced by ore extraction methods and the collapse of abandoned cavities have long been recognized as a hazard to surface structures. A number of approaches have been proposed for the prediction of subsidence on mining sites, and their integration to Geographic Information Systems (GIS) can produce a powerful risk management tool. Nevertheless, this application is often limited by either a lack of generality or excessive computational cost of the methods available.

In this work, the potential for GIS integration of the stochastic subsidence model proposed by Litwiniszyn (1964) was investigated. Conceptually, the model assumes the ground mass as a discontinuous medium, in which particle displacement towards a collapsing cavity is treated as a Markovian process. The accumulation of the discrete movements amounts to the Komolgorov diffusion equation which is then employed to compute surface displacements.

In order to obtain data to test the model in a controlled environment, subsidence in a granular medium was simulated via the Distinct Element Method (DEM). Using a frictional-elastic constitutive law, particle assemblies generated with a range of microstructural and bulk properties were subjected to trapdoor experiments. In each simulation, particle displacement, stresses and changes in the matrix structure were monitored offering insight into the phenomenon.

The behavior of the granular matrix undergoing subsidence was shown to be highly dependent on both its microstructural and bulk properties. The stochastic model followed this trend, performing exceptionally well for medium compacted soils, and diverging in either loose or dense material. The ease of application of the model demonstrates it as a good candidate for GIS applications, however, an extension of the theory might be necessary to render it a more comprehensive prediction tool.