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Geomechanical Technologies for Assessing Three-Dimensional Stability of Underground Excavations Utilizing Remote-Sensing, Finite Element Analysis, and Scientific Visualization

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Abstract : Light detection and ranging (LiDAR) has been a prevalent remote-sensing technology applied in the geological fields due to its high precision and ease of use. One of the major applications is to use the detailed geometrical information of underground structures as a basis for the generation of a three-dimensional numerical model that can be used in a geotechnical stability analysis such as FEM or DEM. To date, however, straightforward techniques in reconstructing the numerical model from the scanned data of the underground structures have not been well established or tested. In this paper, we propose a comprehensive approach integrating all the various processes, from LiDAR scanning to finite element numerical analysis. The study focuses on converting LiDAR 3D point clouds of geologic structures containing complex surface geometries into a finite element model. This methodology has been applied to Kartchner Caverns in Arizona, where detailed underground and surface point clouds can be used for the analysis of underground stability. Numerical simulations were performed using the finite element code Abaqus and presented by 3D computing visualization solution, ParaView. The results are useful in studying the stability of all types of underground excavations including underground mining and tunneling.

Keywords : finite element analysis, LiDAR, remote-sensing, scientific visualization, underground stability
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