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Hazards of quarrying activity: a finite element modeling of human-induced risk of land subsidence above cellar systems cut into porous limestone

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Porous limestone extends within the metropolitan area of Budapest. It has been used as dimension stone for centuries and was exploited by cutting subsurface galleries. The urban development of the city led to the utilization of previously abandoned areas that are undercut by galleries and cellars. The cover bed of the galleries is a porous Miocene limestone with an overburden is less than 25 meters. The construction and land use induces stability problems of subsurface cavities and covering lands. The present study focuses on one the porous limestone areas where extensive land development is under progress. Core drillings with a total length of 100 m were drilled to explore the geological conditions and to obtain materials for laboratory testing. Density properties, compressive strength, tensile strength and triaxial tests were performed under laboratory conditions to provide the input data for finite element modeling. The site area was modeled by using Plaxis 8.2 software to provide information on possible failure and to calculate the stability conditions of cellars. The calculation had several steps starting with an initial stage of natural conditions followed by modeling the distributed load acting on the cellars. The outcome is the distribution of stress fields in the surroundings of the cellars and the displacement zones. Based on the model calculations the reinforcement system of the cellars is under design.