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New Trap-door Test Apparatus and Imaging Technology to Investigate the Mining Induced Ground Subsidence

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Mining-induced ground subsidence is an artificial disaster in a mining area. Shallow mining causes the ground subsidence because the geo-material has the insufficient thickness to generate the arch effect. The subsidence impacts the safety of the buildings and infrastructures near the excavation zone and needs to be identified. Different from the tunneling in civil engineering, besides the safety, mining cost is the first concept for the design. Therefore, mining often parallels to the mineral veins but not always in horizontal. The geometry of jointed rock mass, the mining seam, and the ground surface govern the value and the shape of the ground subsidence. A physical model is required to clarify the mechanism of the mining induced ground subsidence and to verify the correctness of available analysis methods.

In this study, a new trap-door test apparatus, which enables to rotate the trap-door to simulate the mining under different dip-angles of the seam, is developed. The jointed rock mass, which consists of a continuous and a discontinuous joint set, is simulated as aluminum blocks assemble. The ground surface can be adjusted to different angles when packing the aluminum blocks. In addition, traditional laser displacement sensor and the close range photogrammetric technology are integrated into the trap-door test apparatus to evaluate the underground excavation-induced ground subsidence.

Cases of the ground surfaces with different dip angles but parallel to the trap-door and the continuous joint are investigated. Experimental results indicate that the trap door is a new and useful physical model to clarify the rock mass movements induced by underground excavations. The dip angle significantly impacts the shape and the maximum ground subsidence during mining. In addition, the ground subsidence by the close range photogrammetric technology correlates well to the data from the laser displacement sensors.

Further studies regarding the mining or tunneling impacts by the different geometry in rock mass, ground surface, and the seam will be carried out. In addition, the mechanism of the displacement and the arch effect can be clarified by the displacement of each block in the trap door tests using the close range photogrammetric technology.