

Angle and size adjustable large-scale dynamic monitoring similar simulated experiment system for 3D mining-induced fractures

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Abstract: In order to enrich similar simulated experiment study methods on spatiotemporal evolution characteristics of mining-induced fracturing and fractures (MF) in mining and geotechnical engineering, this paper presents a large-scale laboratory angle and size adjustable dynamic monitoring SSE system for 3D-MF (3D-LADMF) which is composed of four subsystems, i.e., the active electro-hydraulic servo hydraulic loading-counterforce subsystem; angle and geometry size adjustable sample chambers; the measurement-control subsystem composed of MaxTest-Load software with 13 control channels, data acquisition sub-subsystem with 128 channels, and the multilevel dynamic monitoring sub-subsystem of 3D-MF; Large area caving machines and tools under tri-axial loading as well as other accessory devices. The features of the 3D-LADMF focus on locating loading-counterforce subsystem in ferroconcrete counterforce pond below the floor, which not only reduced the height of device to easily climbing, but also improved stability. Test specimen can be always under tri-axial loading in the whole process of the experiment, and it's fairly convenient to realize diversified caving and observation with opening or closing the 8 mid-front openings across counterforce wall to sample chamber and equipped caving machines & tools. Through a pair of synchronous telescoping large-tonnage hydraulic jacks and screw hole arrays flexibly setting, large inclination angle ore & rock can be easily well simulated with $0\sim45^\circ$ steplessly adjustable angle of the sample chambers and the geometry size also can be adjusted within $3\text{ m} \times 3\text{ m} \times 3\text{ m}$, $2\text{ m} \times 2\text{ m} \times 2\text{ m}$, $1\text{ m} \times 1\text{ m} \times 1\text{ m}$, et al, thus the 3D-LADMF can meet with experiment requirements under different working conditions and increase equipment usage accordingly. Multichannel data acquisition system is compatible with majority of stress and displacement sensors and data real-time capturing, transmitting and displaying with equipped MaxTest-Load measure-control software which possesses both stress and displacement individual control and self-programming function, and most importantly the holding time can be set arbitrarily to realize tri-axial uniformly or non-uniformly distributed loading by freely group control and full-closed loop control with high precision. Test results shown that 3D-LADMF accords with design accuracy, and what matters is how to use a set of loading-counterforce system and measurement-control system to realize both angle and geometry size adjustable and diversified 3D caving & observation under tri-axial loading in the whole process of the similar simulated experiment. The presented 3D-LADMF creates a favorable test condition for the research of non-linear dynamics problems in geotechnical engineering and especially the spatiotemporal evolution characteristics research of deep coal and rock 3D-MF, which is of wide utilizable prospect in large-scale dynamic monitoring similar simulated experiment in the future.

Key words: Similar simulated experiment; geomechanical model; mined fractures; tri-axial loading; subsurface mining; underground space; large-scale; 3D-LADMF