Surface Subsidence Characteristics Research Using a Three-Dimensional Test Device to Simulate Rock Strata and Surface Movement

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Abstract

IThe primary functions of a three-dimensional test system for mimicking rock formations and surface movement caused by underground coal mining were detailed, and a series of associated tests were performed. An outside frame, a pressurization unit, a pulling unit, and a coal seam simulation component comprised the device. A model test research on the surface subsidence features produced by coal seam mining was carried out using this test apparatus, which was backed by monitoring methods such as the three-dimensional laser scanning method. The transfer law of surface subsidence produced by coal seam mining was discovered when combined with field measurements, and the entire surface subsidence reaction process was investigated. According to the experimental data, subsidence produced by mining disturbances below the coal seam accounts for 79.3 percent of overall subsidence, making it the dominating source of total surface subsidence. Surface subsidence following coal mining may be split into four phases based on long-term surface observations, with the obvious settlement stage accounting for more than 60% of the entire settlement value. The above test results fully reflect the feasibility and practicability of the three-dimensional test device for simulating rock strata and surface movement, as well as providing a new experimental research tool that can be used to further study the surface subsidence characteristics and control caused by coal mining.

Keywords: Rock formations • Surface subsidence law • Surface subsidence process • 3D test device • 3D Laser scanning

Introduction

With the transformation and upgrading of coal development, as well as people's increased awareness of environmental protection issues, the vast majority of coal mines in China will face problems related to coal pressing to protect buildings, structures, water bodies, and other protected bodies during the construction and production process, as well as mining problems that are influenced by protective bodies, that is, problems related to subsidence control and coal mining adsorption. Filling mining, partial mining, coordinated mining, and other technical techniques that decrease subsidence and regulate loss are examples of fundamental technological procedures. Filling mining is a tried-and-true approach for resolving pressed coal issues. This technology supports the rock mass above the mined-out region, preventing surface sinking and damage to surface buildings while fulfilling the aims of effectively extracting coal mine resources and managing surface damage. Controlling the deformation and destruction of infrastructures such as communities, railways, and other structures is one of the pressing issues confronting the mining sector. After mining, the tension in the overlying rock mass is redistributed, generating local stress concentration in the surrounding rock, causing the mined-out area's top to sink, get crushed, or fall. Surface deformation will occur within a particular range when the stress in the support body varies. As a result, it is critical to investigate the impact of stratum movement and surface subsidence on surface settlements and structures during and after coal mining.

There are various theoretical theories and monitoring methods connected to surface sinking, and many accomplishments have been accomplished. Sun, for example, presented a theoretical framework for predicting surface subsidence produced by inclined coal seam mining. Dong investigated the effects of many parameters on tomography. Existing test devices for similar coal mining material simulations are generally two-dimensional test benches that replicate roof and rock formation movement in coal mines and represent established technology, but some surface movement constraints must be considered during simulation. The control process of the coal seam simulation components in three-dimensional test equipment is complex, and successful trial production is difficult or limited by bearing capacity, function, and size, making it difficult to effectively combine these simulations with engineering practices to carry out model tests research. As a result, to better understand the stratum and surface movement characteristics induced by coal mining, this work employs a method combining field data and the fabrication of test equipment to conduct simulation testing. The authors of this paper developed a "three-dimensional test device to simulate the influence of underground coal mining on strata and surface movement," which is used in conjunction with three-dimensional laser scanning technology to perform simulation tests determining surface subsidence after coal mining. The principles of strata and surface movement produced by coal mining are exposed when combined with long-term surface monitoring.

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