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Spectrum characteristics analysis of microseismic signals transmitting between coal bedding ☆

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ABSTRACT

This study was performed to investigate the propagation law of microseismic signals transmitting along the direction parallel and vertical to the bedding in the process of coal rock rupture under uniaxial compression. Microseismic signals during the whole process of coal-rock deformation fracture until burst failure was tested by using the coal rock rupture microseismic experimental system. The empirical mode decomposition graphic, Hilbert spectrum and time–frequency spectrum were obtained by using Hilbert-Huang Transform or HHT. Also the microseismic signals transmitting along the direction parallel and vertical to the bedding in the process of coal rock rupture were spectrum comparative analyzed with EMD analysis method. Results show that amplitude and velocity of microseismic signals changed very small along the parallel direction to bedding in the process of propagation, but microseismic signals delayed and amplitude weakened obviously along the vertical direction to bedding. Signal delay and signal attenuation were confirmed that bedding impact on microseismic wave transmitting.

1. Introduction

As a kind of regional monitoring means with rich spectral components and wideband, microseismic technology (Lu et al., 2008; Jiang et al., 2006; Xie et al., 2004; Jiang and Xun, 2002) can take real-time monitoring on the energy released by spatial fracturing progress of surrounding rock space, roof movement and impulsion pressure and accurate location on vibration events. The amplitude of microseismic is not only related with the damage degree of coal rock, but also the bedding. As a kind of rock, rigid coal has bedding structure. When the coal rock internal rupture, microseismic signals, along the vertical and parallel direction to bedding, have the different amplitude weaken degree and obvious difference on velocity delay under the same strength (Wang et al., 2000). Therefore, it contributes to realize coal rock dynamic disaster monitoring and forecasting to research bedding on the impact on microseismic signals transmitting of impulsion pressure precursors (Zhang et al., 2000; Spetzler et al., 1987; Li et al., 2006).

The paper tested the microseismic signals throughout the whole process of Laohutai coal samples from deformation and fracture to damage with the load equipment of the coal rock uni-axial destroy experiment system (Read et al., 1995; Wang et al., 2004a,b; Lu et al., 2005). It confirmed that there exist significant differences between amplitude attenuation of stress wave along the vertical and parallel direction to bedding based on EMD analysis to microseismic signal (Wang et al., 2003; Ohnaka and Mogi, 1982; Wang et al., 2004a,b).

2. Uni-axial damage microseismic experiment on coal-rock samples

2.1. Uni-axial damage microseismic experiment on coal-rock samples

The load equipment of the coal-rock uniaxial destroy experiment system is one servo material testing machine which can control the loading speed and adjust oil pressure precisely. We can measure uniaxial compressive strength, impact tendentiousness and seismic

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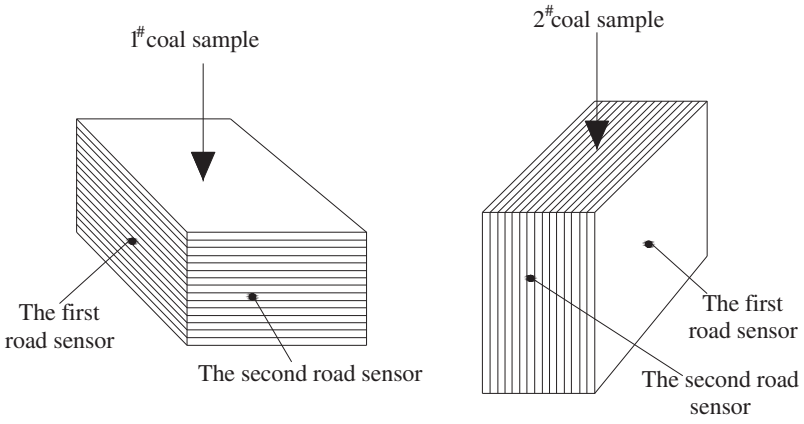

Fig. 1. The arrangement of sensors on coal sample surface.

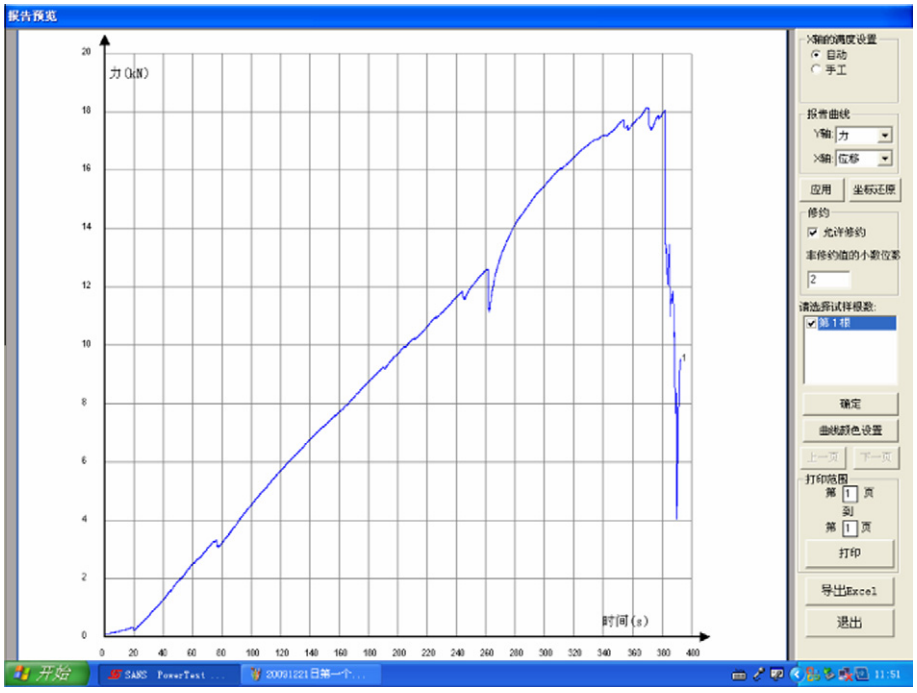

Fig. 2. The relationship between stress and loading time under uniaxial compression of Laohutai coal sample.

change rule of coal. The experimental system consists of microseism sensor, loading system, signal acquisition system and so on. The loading system is composed of Electro-hydraulic Servo Pressure Tester of YAW series controlled by microcomputer, control cabinet, computer and PowerTestV3.4 software. The YAW6106 Electro-hydraulic Servo Pressure Tester, produced by MTS Systems Corporation (China) and electrically controlled, can keep loading for a long time and set complex compression test procedures, so it is suitable for the trial site which needs long-term continuous work. The testing machine, composed of Servo Press and automatic control system, can control the loading method, speed, time and drift automatically, test and record the parameters such as stress, linear strain, and transverse strain and so on synchronously. These enhance the measurement accuracy of load, stress and drift greatly and can get the stress and strain changes of the whole process.

2.2. Coal sample preparation

The coal samples are taken from No. 55002 crossheading in Laohutai Coalmine and formed into cubes with 100 mm side-length by a cut-off machine. For keeping coal sample's original state, the big coal samples are taken from the upper crossheading which is beyond 100 m in front of the working face during the sampling process and all samples belong to the same layer in the vertical stratification and near the same place in the horizontal direction. We use dry drilled, dry cutting and dry grinding during the workpiece process at the lab and reduce the machine speed as far as possible, meanwhile, we must do ultrasonic speed test for the processed coal samples and make records. Excluding the coal samples with obvious microseismic fracture, we get more than 10 coal samples to satisfy test requirements.

2.3. Sensor arrangement

Microseismic sensors are used to receive microseismic signals generated by deformation and fracture of coal-rock samples. Before sensors arrangement, we should clean the position gently with alcohol that installs microseismic sensors, then stick sensors to the samples with Vaseline and cling it with adhesive tape. The pressure on the tape we use should be the same each time to make