Study of the Uniaxial Dynamic Behavior of Salt Rock under Static Triaxial Pre-compression

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Summary In order to understand the uniaxial dynamic behavior of salt rock under static triaxial pre-compression, a special Spilt Hopkinsion Pressure Bar (SHPB) device was designed. Many experiments were carried out to investigate the dynamic behavior of salt rock under different static triaxial pre-compression and at different strain rates.

Introduction

Hunsche(1984, 1985, 1990)[1~3], Hansen et al.(1984)[4], Farmer et al.(1984)[5] and Skrotzki(1984)[6] have done some researches on the static mechanical behavior of salt rock for its short-term strength and deformation characteristics, which are mainly done by uniaxial compression, triaxial compression and shearing tests. Yang C H et al.[7] researched on the creep performance of salt rock, and indicated that the confining pressure has obvious effects on the steady-state creep rate of the salt rock when lower surrounding pressure, while the confining pressure effect disappears beyond the critical value. However, little research was published about the experiments on salt rock using the method of SHPB. Moreover, nearly no researches were conducted on the strain rate effect of salt rock under triaxial static pre-compression.

Experiment

A typical SHPB setup is composed of incident bar, transmission bar and a short specimen sandwiched between them (Fig.1)[8][9]. In order to carry out the experiments, the triaxial pre-compression device was designed to improve a typical SHPB system. It is composed of three parts called the confining pressure device, the axial compression device and the hydraulic oil supply device respectively showed in Fig.2 and Fig.3. There're two pull rods undertaking huge tension generated within the system as the axial compression applied shown in Fig.1 and Fig.2. The above design makes it much simpler for applying the axial compression than building a strong thrust device outside of the system. Meanwhile, some special springs were used to keep the axial compression pulse generated in the incident bar from unloading.

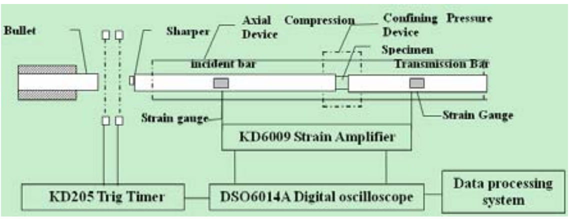

Fig.1 The schematic diagram of the designed SHPB device

Fig.2 The axial compression device

Fig.3 The confining pressure device

Experimental results and analysis

Fig.4 is a typical waveform gotten from SHPB system for salt rock. Ch1 and Ch2 are signals recorded from incident bar, and Ch3 and Ch4 are signals recorded from transmitted bar. The axial pre-compression and the surrounding confining compression were equaled, the values of which were 5MPa, 15MPa and 25MPa, respectively. The

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a) Corresponding author. Jiang Xiquan Email:xiquanjiang@yahoo.com.cn
b) supported by a grant from the Major State Basic Research Development Program of China (973 Program) (No. 2009CB724608)

stress-strain relationship curves of all the 17 specimens are shown in Fig.5.

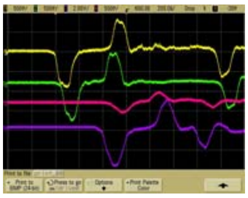

Fig.4 The waveform for SHPB

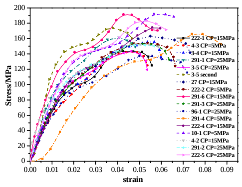

Fig.5 The stress-strain relationship of the specimens Note: CP is for confining pressure

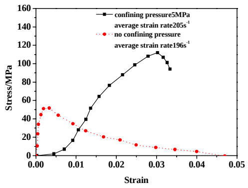

Fig.6 Comparisons of the specimens with and without confining pressure under the same strain rate

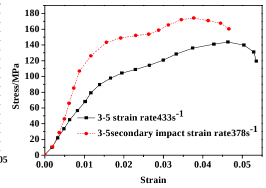

Fig.7 Contrast of one hit and secondary impact of the specimen No. 3-5

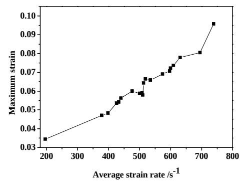

Fig.8 The relationship of average strain rate and maximum strain for all specimens

It can be seen from the Fig.5 that the confining pressure has little effect on the mechanical behavior of the salt rock. But the mechanical behavior of the salt rock changed a lot with and without the confining pressure (Fig. 6).

Fig.7 gives the dynamic stress-strain relationship curves of the specimens subjected to single and twice impact respectively under the same confining pressure.

From the Fig. 8, it can be found that the strain rate has some effect on the maximum dynamic strain of salt rock subjected to triaxial pre-compression.

Conclusion

Triaxial static pre-compression has great effect on stress hardening performance of salt rock, the dynamic compressive strength with confining pressure increases obviously than which without the confining pressure. While the confining pressure has little effect on the mechanical behavior of the salt rock under the higher pressure, such as 15MPa and 25MPa.

Salt rock can be undergone more than two impacts, and the first impact makes the porosity of salt rock lower, and its strength higher.

The salt rock is the rate-sensitive material. However, the strain rate has little effect on the maximum dynamic strength, but has some effect on the maximum dynamic strain of salt rock subjected to a triaxial pre-compression.

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