Study of coal bump mechanics and AE of coal with different strength

冲击地压机理与不同强度煤体声发射研究

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Contents

一、Background 研究背景

1.1. Coal bump mechanisms 震源

Seimic source

震源

Does seismic source exist in a coal bump event? Yes or no?

Who can prove this?

And the bump event is about 150m horizontal distance and -60 to +90m around the bump event, is it true?

一、Background 研究背景

1.2. Is floor heave is a coal bump?

Where is dynamic energy? And, can the floor heave be realise by a so-called static loading?

If you answer is NO, then, could you explain why a coal bump occurs by the material other than coal?

You cann’t explain…

一、Background 研究背景

1.3. Why did not gob side entry occur a coal bump?

According to the gob side entry report in the literature, there is no coal bump at all. I asked Prod Bai yesterday, all night, did not find any bump event. So, can we conclude that gob side entry does not occur coal bump at all?

Don’t tell me what is a gob side entry retaining method…

一、Background 研究背景

1.3. What is the basis of so-called Strong-weak-strong structure?

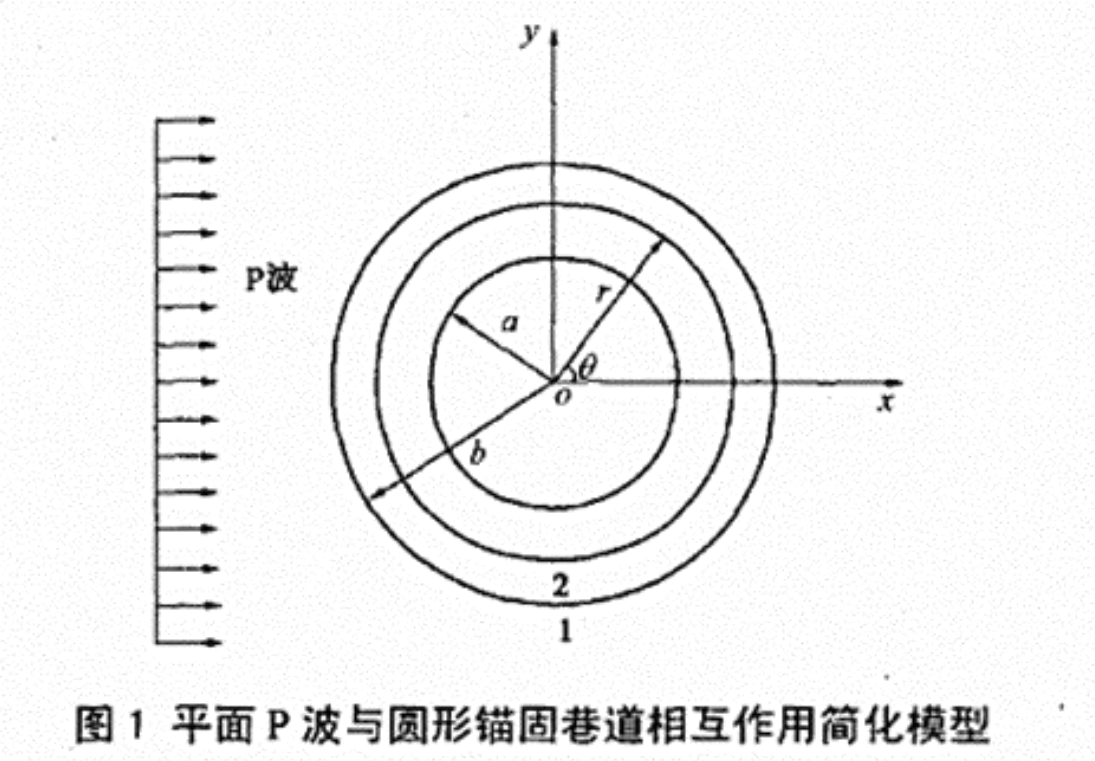
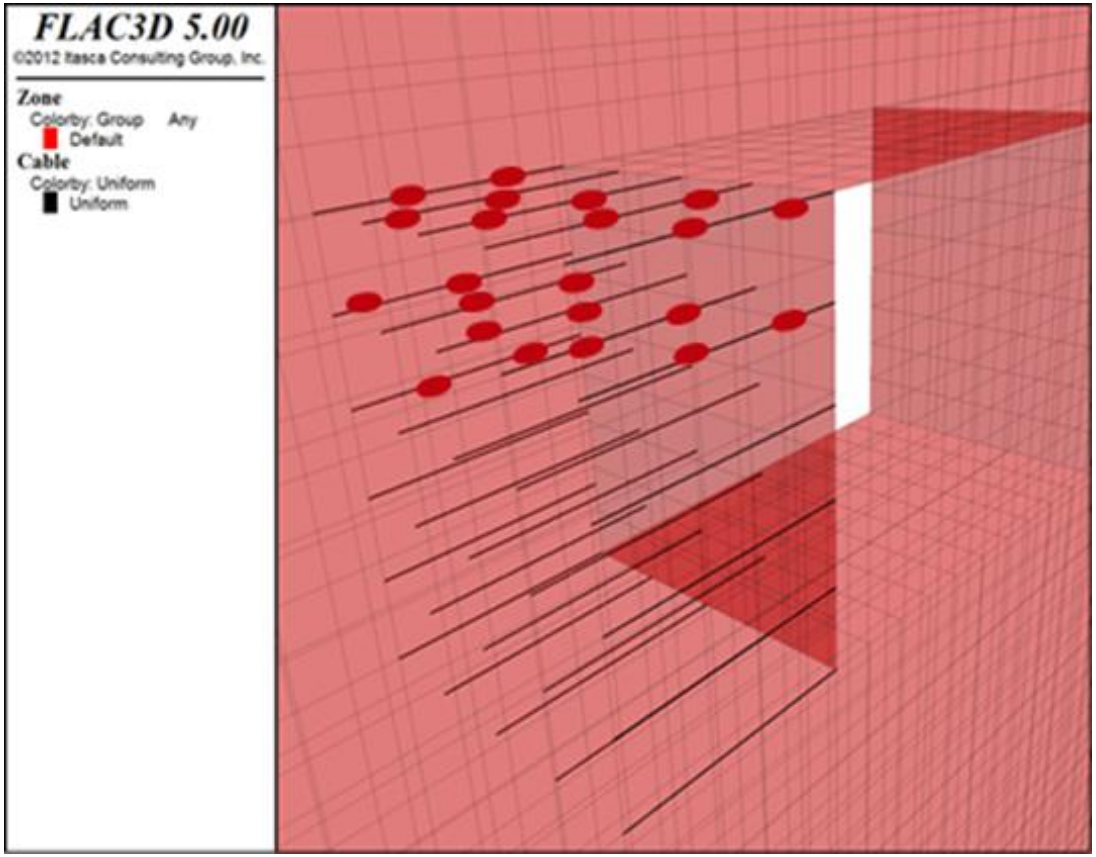


图 1 平面 P 波与圆形锚固巷道相互作用简化模型

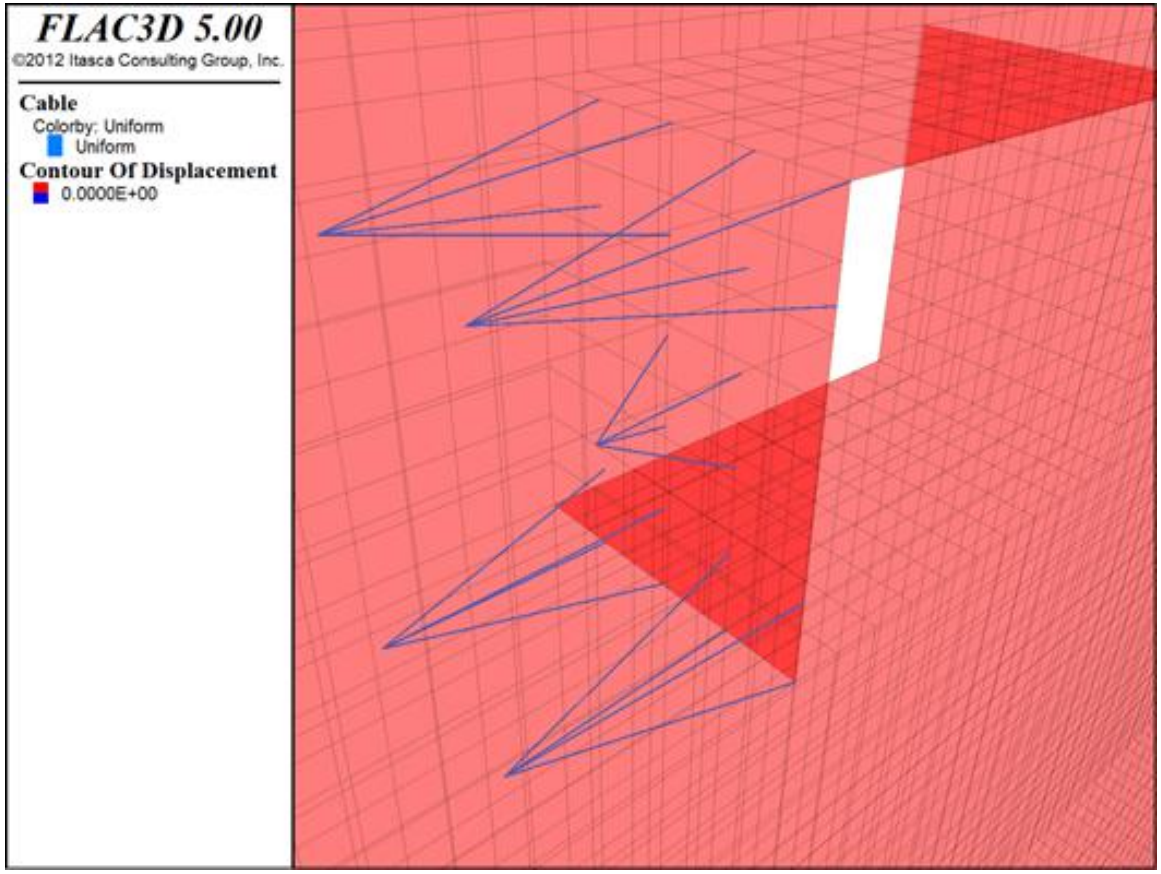
一、Background 研究背景

1.3. If the mechanical wave is a concern…



一、Background 研究背景

1.3. If the mechanical wave is a concern…



一、Background 研究背景

1.3. what I think?

Floor heave coal event is static unstable event; i.e., it is not a dynamic dominant event at all, if, you cannot prove it occurs with a throw huge material, huge sound and huge air wave.

I did not find any approve in literature, yet.

一、Background 研究背景

1.3. what I think?

2nd, I think that the coal bump occurs in the development is very similar to that of hard rockburst in the TMB driving head. It is a crater （弹坑）failure caused by stress-wave, which follows the elastic wave theory.

一、Background 研究背景

1.3. what I think?

3rd, coal bump occurs in the coal, and it closely relates to the structure of the coal, such as joints and cleat, but is not related to the microscope structure or molecular structure of the coal.

Can I prove it? I can't.

一、Background 研究背景

1.3. what I think?

4th, coal bump occurs in the gateways, is closely relates to the seismic resource, which releases a mechanical wave and generates a stress wave at the surface of the tunnel, which finally causes a bump event.

Can I prove it? I can't.

However, roof breakage seems to reduce the total energy generate in the rock, and the borehole technology seems to reduce the strength of the stress wave.

一、Background 研究背景

1.4. what I think?

5th, fault coal bump is volumatic increase of the material, it cannot be predicted.

一、Background 研究背景

1.4. what I did?

We did nothing, but some experiments to verify our hypnoses, such as the importance of features of the coal structure.

Please see below:

一、Background 研究背景

1.Research significance 声发射研究的意义

The stability and failure mechanism of coal and rock is closely related to coal bump disaster.

Ground stress re-distribution causes coal structure change, sudden release of energy accompanied with elastic wave is the so-called acoustic emission (AE). Continuous observation of the acoustic emission is a way to understand the failure mechanism of coal and rock.

煤岩稳定性和破坏机制研究具有重要意义；

煤岩体应力的重新分布，造成煤体结构发生变化，并突然释放能量且伴随弹性波的现象称为声发射，通过对煤岩体声发射的动态连续观测，可以推断出煤岩体的破坏机制。

一、 Background 研究背景

2. AE study review 煤岩体声发射技术研究现状

- Study the seepage of high gas contents coal;
- Study coal bump proneness by uniaxial or triaxial tests;
- The influence of water contents and loading rates;
- Coal and rock failure procedure.

- 利用声发射技术对含瓦斯煤的损伤演化规律和渗流特性进行研究
- 对煤岩体的单轴、三轴加载，通过声发射特征评价煤层的冲击倾向性
- 研究含水率、加载速率等声发射特征及煤岩体损伤机制
- 分析岩石破坏的声发射机理和规律

二、不同强度煤体声发射实验

This paper compares the AE characteristics of soft coal and hard coal.

The AE characteristics of coal with different strengths, such as ringing count and energy, are studied and compared under uniaxial compression tests, the development of AE is analysed.

对软煤、硬煤的声发射特征研究不足。

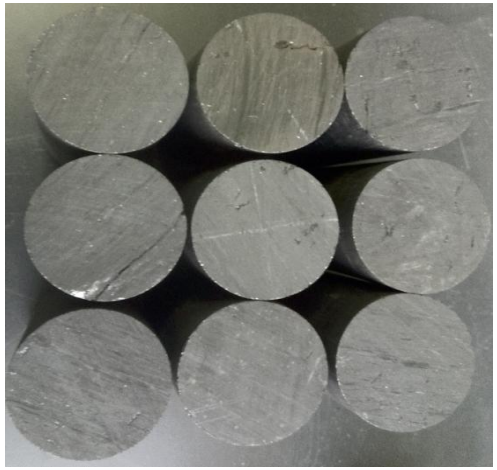
为研究不同强度煤体声发射特征，本项研究通过对软煤和硬煤单轴压缩实验，分析声发射的振铃计数、能量等参数，对比软煤和硬煤的声发射规律与特征。

二、Method 不同强度煤体声发射实验

1. Specimen 实验试样

The test samples are taken from Xinzhou Yao Mine (UCS 30 MPa, with bump proneness) and Dongrong No. 2 Mine (UCS 10 MPa, without bump proneness).

试验煤体试样取自大同矿区忻州窑矿(UCS 30 MPa，有冲击倾向)和双鸭山矿区东荣二矿(UCS 10 MPa，无冲击倾向)



部分煤体试块
Coal samples

二、不同强度煤体声发射实验

2. Equipments 实验仪器

Testing equipment is shown below.

声发射系统SAEU2S数字声发射系统，其传感器型号为SR150M，前置放大器采用的型号为40 dB；单轴压缩的试验机WAW-600C型微机控制电液伺服万能试验机。

声发射采集系统主机
Acoustic emission acquisition case

试验机
Testing machine

二、不同强度煤体声发射实验

3. Parameters 参数设置

The testing machine is displacement controlled, loading rate 0.5 mm/min.

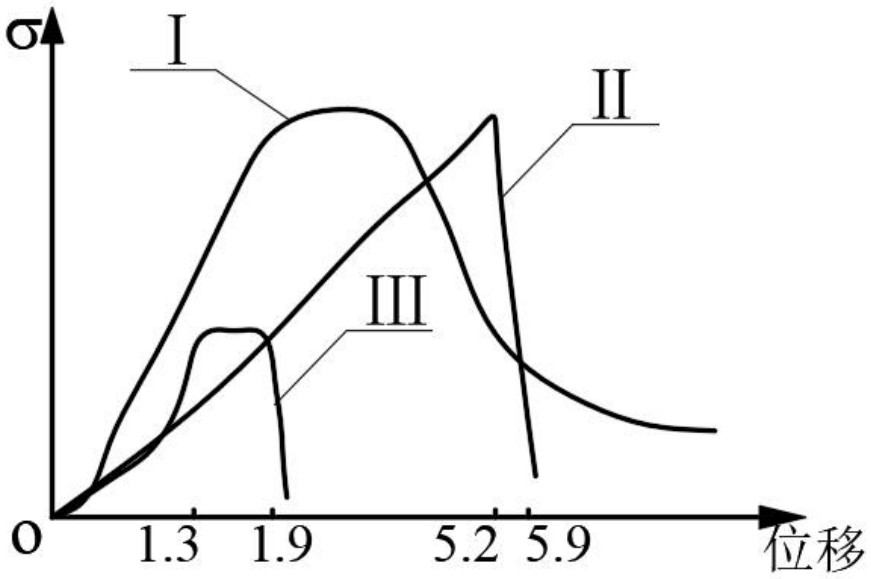
To filter noise, the threshold value of AE detection is 45 dB. The timing parameters are set as follows: peak definition time (PDT) is 300 μs, impact definition time (HDT) is 600 μs, impact locking time (HLT) is 1000 μs, and sound speed is 1.8 km/s.

试验机采用位移方式控制，加载速度为0.5 mm/min。

为过滤噪声, 声发射检测的门限值为45 dB；定时参数分别设置为：峰值定义时间（PDT）为300 μs，撞击定义时间（HDT）为600 μs，撞击闭锁时间（HLT）为1000 μs；声速设置为1.8 km/s。

三、Result 实验结果分析

1. Strength 强度特征



I-Typical Load-displacement curve

I-典型应力应变曲线

II-Hard coal compressive curve

II-硬岩应力应变曲线

III Soft coal compressive curve

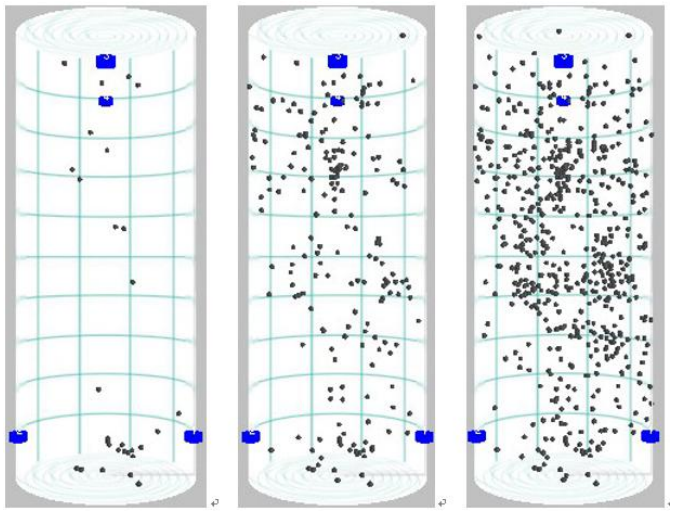
III-软岩应力应变曲线

Their strengths are different; and

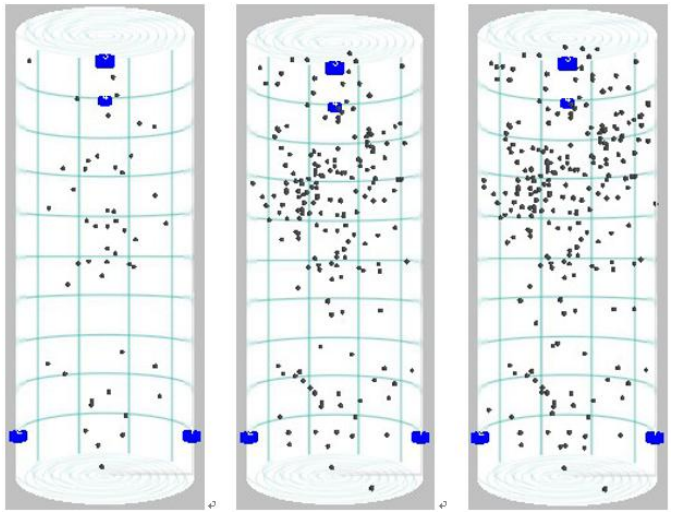
Hard coal shows a brittle characteristic, and soft coal is a ductile material.

三、实验结果分析

2. Cracks 破裂点特征



忻州窑矿煤体试样破裂点
Hard coal



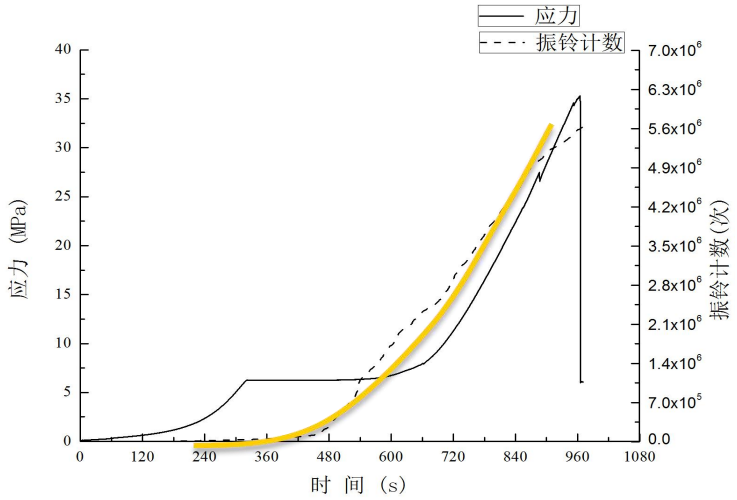
双鸭山煤体试样破裂点
Soft coal

With the increase of load, the frequency of AE increases. The hard coal has more crack than the soft coal, but the distribution is no difference.

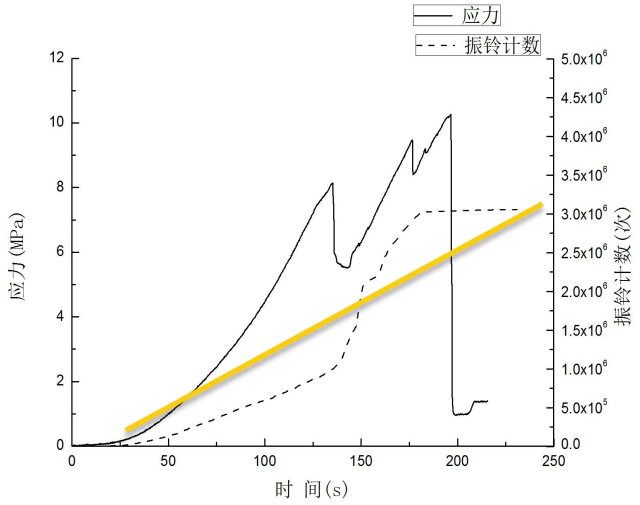
随着载荷的增大，试件内部发生声发射的频率逐渐增加。通过对两组试件破裂点的对比，硬煤破裂点较软煤多，但分布差别不大。

三、实验结果分析

3. Ring count 振铃分析



Hard coal



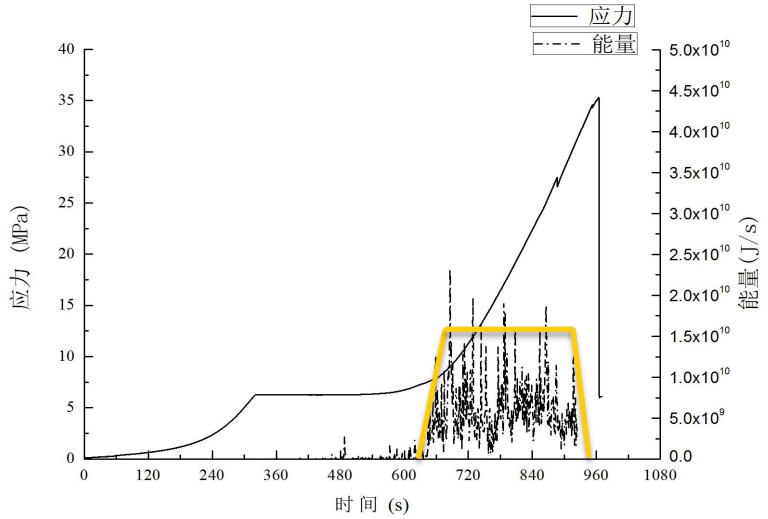
Soft coal

The average ring counts of hard coal and soft coal are 6.7×10^6 and 4.5×10^6 respectively (49% higher). Hard coal ring count curve is similar to high order curve, soft coal is similar to linear function.

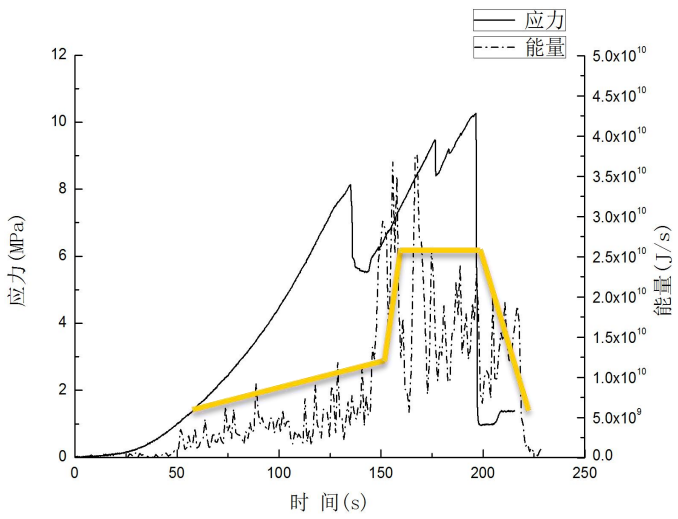
硬煤平均振铃次数为6.7×10^6，软煤的平均振铃次数为4.5×10^6，硬煤振铃次数较软煤增加49%。硬煤振铃次数曲线类似高次函数，软煤振铃次数类似线性函数。

三、实验结果分析

4. Energy 能量特征分析



Hard coal



Soft coal

Their peak energies are similar, however, the loading time and the energy dissipation of hard coal is higher. Hard coal curve is similar to a platform, soft coal curve is similar to normal distribution.

两组试样能量峰值差别不大，但硬煤破坏前加载时间更长，吸能更多。硬煤曲线类似平台，软煤类似正态分布。

四、Conclusion 结论与展望

（1）The compressive curve is quite different for hard coal and soft coal, showing brittle and ductile characteristics of them.

（2）The hard coal has more crack than the soft coal, but the distribution is similiar.

（3）The average ring counts of hard coal and soft coal are 6.7×10^6 and 4.5×10^6 respectively (49% higher).

（4）the loading time and the energy dissipation of hard coal is higher.

汇报结束

Thank you !