岩石力学与工程学报 » 2012, Vol. 31 » Issue (s2) :3855-3863 DOI:

含孔洞硬岩破坏过程的离散元分析

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DISCRETE ELEMENT ANALYSIS OF FAILURE PROCESS OF HARD ROCK WITH A PRE-EXISTING CIRCULAR OPENING

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摘要 基于颗粒离散元理论，采用数值试验模拟含孔洞凝灰质砂岩在单轴、双轴和三轴压缩条件下的破坏过程，并从峰值强度、微裂纹数目和能量等角度分析不同加载方式的影响。研究结果表明：无论采用何种加载方式，试样破坏均是从孔洞周边开始的；单轴压缩的孔洞变形与双轴及三轴压缩不同，且在试样侧面中间形成一条明显的贯通拉裂缝；三轴压缩对试样承载能力的提高明显大于双轴压缩，且围压越大，两者对试样承载能力的提高幅度之差越大；双轴压缩条件下试样的起裂应力随着围压的增大而减小，而三轴压缩条件下试样的起裂应力随着围压的增大而增大；应变能的变化过程可以反映试样的破坏过程，其峰值主要受围压影响；耗散能的变化过程可以体现试样破坏过程中细观颗粒的滑移、摩擦程度，其变化规律与加载方式和围压均有关。

关键词： 岩石力学 离散元 细观力学 数值试验 应变能

Abstract： Based on the theory of particle flow code，the failure process of tuffaceous sandstone with a pre-existing circular opening is simulated by numerical experiments under uniaxial，biaxial and triaxial compressions. And the impact of different loading modes is analyzed from the view of peak strength，microcrack and energy. The results show that the failure of rock specimen starts around the opening regardless of loading modes. The deformation of opening under uniaxial compression is different from that under biaxial and triaxial compressions. And a macro-crack is formed on the side of rock specimen under uniaxial compression. Peak strength of rock specimen under triaxial compression is larger than that of biaxial compression at the same confining pressure. And the difference of peak strength between biaxial and triaxial compressions increases with the increase of confining pressure. Crack-initiation stress decreases with the increase of confining pressure under biaxial compression，while crack-initiation stress increases with the increase of confining pressure under triaxial compression. The change process of strain energy can reflect the failure process of rock specimen. And its peak value is greatly influenced by confining pressure. The change process of dissipated energy can reflect the extent of slip and friction between microscopic particles. And its change law is related to loading modes and confining pressure.

Keywords： rock mechanics discrete element mesomechanics numerical experiment strain energy

Received 2011-12-06;

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张社荣1，孙 博1，王 超1，严 磊2，3.含孔洞硬岩破坏过程的离散元分析[J] 岩石力学与工程学报, 2012,V31(s2): 3855-3863

ZHANG Sherong1，SUN Bo1，WANG Chao1，YAN Lei2，3.DISCRETE ELEMENT ANALYSIS OF FAILURE PROCESS OF HARD ROCK WITH A PRE-EXISTING CIRCULAR OPENING[J] ，2012,V31(s2): 3855-3863