岩土工程学报
主办单位：中国水利学会，中国土木工程学会
中国力学学会，中国建筑学会，
中国水力发电工程学会，中国振动工程学会
主编：陈生水

岩土工程学报 » 2010, Vol. 32 » Issue (12) :1875-1881 DOI:

水压致裂过程的三维数值模拟研究

李根[1],唐春安[2],梁正召[3],李连崇[4]*

1. 大连理工大学岩石破裂与失稳研究中心
2. 大连大学材料破坏力学数值试验研究中心
3. 大连理工大学土木水利学院岩石破裂与失稳研究中心
4. 大连理工大学土木水利学院

Numerical simulation of 3D hydraulic fracturing process

摘要 基于RFPA数值分析方法和并行计算技术，建立了反映岩石细观损伤演化过程的三维渗流－应力－损伤耦合模型。对具有120万单元的方形岩石材料模型，进行了4组不同应力状态下水压致裂过程的三维大规模科学计算分析。计算结果分析表明：起裂压力与失稳压力并不重合，起始裂纹均为张性，裂纹扩展形式、表面平整度、走向、扩展失稳过程以及裂纹的空间分布形态受应力状态影响。当竖直方向为最大主应力方向时裂纹呈空间竖片分布，当水平应力差较大时裂纹表面形态平整，失稳到来较快；当竖直方向为最小主应力方向时裂纹的空间分布呈水平片状；不等的主应力情况下裂纹总是分布在最小主应力面内；当三向主应力相等时，裂纹起裂位置和扩展方向具有竞争趋势，空间分布不具规律，裂缝分支较多。数值模拟结果与物理实验结果有着较好的吻合，该研究对水压致裂工程设计有一定参考价值。

关键词： 流固耦合 并行有限元计算 三维水压致裂 数值模拟

Abstract： Based on the RFPA numerical method and the parallel technology, a microscopic hydro-mechanical coupling model to reflect the process of rock damage is established. For a square rock model with 1200000 elements, 3D scientific computation is performed during the process of hydraulic fracturing under 4 different stress states. The results show that the initial pressure doesn't coincide with the buckling pressure, and that the extension form, surface planeness, tendency, extension instability process which is tensional and spatial distribution shape of cracks are influenced by the stress states. Cracks are distributed in the form of shaft film when the maximum principal stress direction is vertical, if the horizontal stress difference is bigger, instability is faster, and the crack surface is plane. Cracks are distributed in the form of shaft film when the minimum principal stress direction is horizontal. Cracks are always distributed in the minimum stress direction plane under different principal stress situations. There is competition trend between initiation location and propagation direction when the 3D principal stresses are equal, and there is no laws in space distribution and cracks are branched. Numerical simulation results are in accordance are with physical experimental ones. The study is valuable to the engineering design of hydraulic fracturing.

Keywords： fluid-solid coupling parallel FEM computation 3D hydraulic fracturing numerical simulation

Received 2009-07-01; published 2011-01-11

Fund:国家自然科学基金委员会、雅砻江水电开发联合研究基金重点项目;国家重点基础研究发展计划项目

Corresponding Authors: 李根 Email: badboy955@163.com

引用本文:

李根 唐春安 梁正召 李连崇.水压致裂过程的三维数值模拟研究 [J] 岩土工程学报, 2010,V32(12): 1875-1881

.Numerical simulation of 3D hydraulic fracturing process[J] Chinese J. Geot. Eng., 2010,V32(12): 1875-1881

链接本文:

http://218.241.156.197/Jwk_ytgcxb/CN/ 或 http://218.241.156.197/Jwk_ytgcxb/CN/Y2010/V32/I12/1875