基于水平集坐标的二维压剪节理动态扩展过程无网格法模拟研究

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SIMULATION FOR 2D COMPRESSION-SHEAR JOINT DYNAMIC PROPAGATION PROCESS USING MESHLESS METHODS BASED ON LEVEL SETS COORDINATES

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摘要 发展能有效模拟岩体节理拉压破坏动态扩展过程的无网格模拟方法，构造岩体节理张开和闭合接触摩擦行为的无网格法近似函数，采用水平集坐标描述和捕捉节理在扩展过程中的几何信息。当节理张开时，引入断裂线，并采用衍射准则引入位移跳跃项。当节理闭合时，提出类似于Goodman接触摩擦单元的无网格近似函数构造方法，考虑节理面上、下两侧的相对滑动和法向接触。与Goodman单元或以往的无网格模拟不同，本文的接触方法基于材料点而非结点，并与水平集坐标更新算法结合，在处理节理模型生成和动态扩展后的模型更新上更灵活、简便，且具有通用性。通过测试拉剪、压剪破坏单节理和雁行节理的静态和动态破坏扩展过程的算例，验证了本文方法的正确性和有效性。

关键词： 岩石力学 节理扩展 无网格法 节理闭合 水平集 接触摩擦

Abstract： The contract and frictional algorithms are developed in the meshless method，element-free Galerkin method for modelling 2D crack propagation in rock mass subjected to compressive and tensile loading conditions. Here，the level set method is used to describe the crack geometry. To capture the displacement jump across the joint when the join is open，the diffraction rule is used to modify the weight function；and hence construction of the discontinuous meshless approximation. The joint closure is modeled by a new meshless frictional sliding and contact algorithm，which is similar to the well known Goodman element in the family of finite elements to model the sliding and contact between joint surfaces. Different from Goodman element and former meshless methods，the construction of present method is based on the material points instead of the nodes，and thereby it performs better and is more flexible in model generation of a joint of complex geometry. The material points and nodes generation after joint propagation is based on the level sets functions which have a general form for arbitrary crack in 2D. A number of examples are tested to model the crack propagation in rock samples subjected to compression and tension showing the correctness of the method.

Keywords： rock mechanics joint propagation meshless methods joint closure level sets contact and friction

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