

含复杂裂隙网络岩体渗流特性研究的复合单元法

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摘要 研究含复杂裂隙网络岩体渗流特性的复合单元法, 该方法首先利用蒙特卡罗方法随机生成符合给定概率分布特征的复杂裂隙网络; 然后通过交切和拓扑运算将各裂隙段置于常规有限单元内部, 形成内含由多个裂隙段分划而成的子单元的复合单元, 根据推导的公式计算渗流场进而分析岩体的渗透特性。该方法具有以下几个主要特点: (1) 可与传统的有限元法融合; (2) 可考虑每条裂隙的具体位置、产状、开度、长度和渗透性质; (3) 可考虑岩石的渗透性及其与裂隙间的流量交换; (4) 可计入不连通裂隙对渗流场的影响; (5) 复合单元的拓扑信息由裂隙网络与常规有限单元边界的交切及其单元内部裂隙段的相互交切而生成, 由于先没有考虑裂隙, 故复合单元前处理简单。用复合单元法分析含复杂裂隙网络岩体的渗流行为及其渗流特性是一种新的数值模拟手段。算例分析表明该方法的可行性和有效性。

关键词 [渗流力学](#); [裂隙网络](#); [岩体](#); [蒙特卡罗方法](#); [随机模拟](#); [复合单元法](#)

分类号

COMPOSITE ELEMENT METHOD FOR SEEPAGE CHARACTERISTICS STUDY ON ROCK MASSES WITH COMPLICATED FRACTURE NETWORK

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Abstract

The composite element method for the seepage problem in the rock masses containing complicated fracture network is studied. Firstly, the Monte Carlo method is adopted to generate the stochastic fracture network according to the given probability distribution features; and then the fracture network is located within the conventional finite element to form composite element, which is composed of several subelements incised by the fracture segments. Based on the deduced algorithm, the nodal hydraulic potential of respective subelements can be calculated; and then the analysis of the seepage characteristic in rock masses is performed. The main features of this method are as follows: (1) it can be integrated into conventional finite element method; (2) the number, position, orientation, trace and aperture of every fracture are taken into consideration in the analysis; (3) the permeability of rock and the flow exchange between rock and fractures are considered; (4) the obturated fractures are not omitted and their effects on the seepage are taken into account; and (5) the topological information of composite elements is obtained by the intersection and incision

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between the fractures and the finite element boundaries and those among the fractures themselves. In this way, the composite element mesh generation of rock masses is not restricted by fractures and can be considerably simplified. The composite element method provides a new approach of the numerical simulation for the seepage solution in the rock masses containing complicated fracture network. The feasibility and effectiveness of this method are verified by the numerical example.

Key words [seepage mechanics](#); [fracture network](#); [rock masses](#); [Monte Carlo method](#); [stochastic simulation](#); [composite element method](#)

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