

多孔岩石局部化变形的应力分布及演化规律的数值模拟研究

Numerical simulation on stress distribution and evolution law of strain localization in porous rocks

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摘要: 多孔岩石局部化变形的产生和扩展是岩石宏观失稳的萌芽阶段, 其力学行为特征的研究对工程安全建设具有重要意义。目前, 对于应力作用下多孔岩石局部化变形的相关研究已形成系统性理论, 但其微观破裂的动态过程、应力场的分布及演化特征仍缺乏有力直观证据。因此, 本文以 Leitha 灰岩为研究对象, 开展常规三轴压缩实验, 利用动态 CT 成像技术, 实时观测多孔岩石局部化变形产生及破裂成核过程。以获取的真实 CT 数据作为建模文件, 利用离散元的数值模拟方法, 从微观角度分析多孔灰岩在应力作用下局部化变形演化规律。研究发现: 模型局部化变形的产生和扩展过程与实际数据基本一致, 在多孔岩石局部化变形产生前, 孔周存在高应力集中现象。本文进一步系统阐述了多孔岩石在应力作用下孔隙坍塌及颗粒挤碎的应力分布及演化规律。

关键词: 离散元; CT 成像; 局部化变形

Abstract: The formation and development of strain localization of porous rocks is the initial stage of rocks macroscopic instability, and the study of their stress behavior characteristics is of great significance for engineering safety construction. At present, a systematic theory has been formed for the study of the strain localization of porous rocks under stress, but there is still a lack of detailed micro evidence on the dynamic process of microscopic fracture, the distribution and evolution characteristics of stress field. Therefore, in this study, taking the Leitha limestones as the research object, we have conducted the conventional triaxial compression experiment, and observed the strain localization and fracture nucleation process of the porous rocks in real time by using dynamic CT imaging technology. Based on the CT data obtained as the modeling file, discrete elements method (DEM) simulation was used to analyze the evolution of strain localization of porous limestones under stress from a microscopic perspective. The results show that the generation and expansion process of the model's strain localization is basically consistent with the experimental data of stress behavior, and there is a high stress concentration around the pores before strain localization formation of porous rocks. In this paper, the stress distribution and evolution of pore collapse and grain crushing of porous rocks under stress are further systematically expounded.

Keywords: Discrete Elements Method; CT imaging; strain localization