

论文

冻融岩石损伤劣化及力学特性试验研究

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摘要:

采用实验研究与损伤力学理论分析相结合的研究方法,对砂岩和页岩进行开放饱水状态下的冻融循环试验,并对经历不同冻融次数后的岩样进行单向受力状态下的力学特性试验;分析了岩石的冻融损伤劣化过程,系统研究了岩石的强度与变形特性、应力-应变曲线及损伤扩展力学特性随冻融循环次数的变化规律,并对两种岩石冻融损伤的同一性和差异性进行比较。研究表明:砂岩的冻融损伤劣化模式主要为剥落模式和断裂模式,最终由于冻融损伤而崩解;而页岩为裂纹模式,冻融耐久性相对较强。随着冻融循环次数的增加,两种岩石的弹性模量及强度减小,应力-应变曲线压缩性增大,弹性增长段减小;砂岩表现出延性增强,脆性减弱的特征,而页岩在冻融循环达到一定次数后其力学性质趋于稳定。相比而言,砂岩对冻融循环反映更敏感,压密段更明显,塑性更强。岩石初始细观结构的不同经过损伤的非线性演化,表现出终态宏观特性的差异。

关键词: 冻融循环; 试验研究; 损伤; 力学特性

Experimental study of damage deterioration and mechanical properties for freezing thawing rock

Abstract:

Using the combined method of experiment and damage mechanical theoretical analysis, the freeze thaw cycling experiment was conducted on sandstone and shale under an open system and water saturated state, and then the mechanical properties experiment was carried out under unidirectional force state on different freeze thaw cycles. Subsequently, the rock damage deterioration process under freeze thaw cycles was analyzed, the variation laws of rock strength and deformation features, the stress strain curve and damage propagation mechanical characteristics on the influence of freeze thaw cycles were systematically studied, and the identity and discrepancy of freeze thaw damage were compared for two types of rock. The result shows that the primary modes of freeze thaw damage deterioration for sandstone are spalling mode and fracture mode, and eventually the sandstone completely collapses, while for shale, the damage is in a crack mode, and the resistance to freeze thaw is relatively strong. The more the times of freeze thaw cycles are, the more reduction of the elastic modulus and strength, while the compaction property of stress strain curve increases and the elastic growth period decreases. Sandstone exhibits the characteristics of enhanced ductility and weakened brittleness, while the mechanical characteristics of shale tends to be steady after the freeze thaw cycles reaches to certain times. Compared with shale, sandstone is more sensitive to the freeze thaw cycles, its compacting segment is more obvious and the plasticity is stronger. Through the nonlinear damage evolution, the differences of initial meso structure within the rocks demonstrate the distinctive macroscopic characteristics in their final state.

Keywords: freeze thaw cycle; experimental study; damage; mechanical characteristics

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