

不同温度梯度冻结粘土破坏形态及抗压强度分析

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Research on the Failure Mode and the Compression Strength for the Frozen Clay at Different Temperature Gradients

摘要

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摘要 采用先冻结后固结(GFC)的冻土试验方法进行3种温度梯度冻结黏土的三轴压缩试验,研究不同温度梯度冻土破坏形态以及温度梯度、围压对冻土强度的弱化效应。结果表明:①温度梯度对冻土破坏形态有明显影响,而围压的影响与温度梯度相比则可以忽略。不同温度梯度冻土破坏形态呈下端“胀开”型,均匀温度冻土破坏形态呈“腰鼓”型;不同温度梯度冻土破坏后的径向膨胀量和垂向压缩量沿不同试样高度的非均匀分布是温度梯度诱导的“非均质”效应的重要体现,且这种“非均质”程度随温度梯度增加而加强;②温度梯度对冻土破坏体积变形具有和温度相同的影响效应,即随温度梯度增加(或温度的增加),不同围压冻土破坏后的体积变形由体缩逐渐过渡到体胀。③相同围压冻土强度随温度梯度增加而衰减,不同温度梯度冻土强度随围压增加而变化的规律与均匀温度场相同,均可理解为受微裂隙发育和孔隙冰压融影响而先增加后降低,但围压的弱化程度与温度梯度密切相关。④不同温度梯度冻土的三轴压缩强度可通过建立在主应力空间中分段线性屈服准则修正后予以描述。

关键词: 冻结黏土 温度梯度 破坏形态 抗压强度 弱化效应 非均质效应

Abstract: The triaxial compression tests are performed on the frozen clay under three thermal gradients by use of the GFC (freezing with thermal gradient, isotropically consolidation) method. The failure modes under different thermal gradients and the weakening effects of thermal gradients and the confining pressure on the strength are investigated. The results indicate that: (1) The thermal gradients have significant influences on the failure modes of the frozen soil. However, the effects of the confining pressure can be ignored compared with the thermal gradients. The failure modes under different thermal gradients present bottom bursting characteristics, but show middle bursting characteristics in the homogenous thermal field. The non-uniform distribution laws for the radial expanding amplitude and the vertical compression amplitude are the main forms of the “inhomogenous effects”, which are enhanced as the thermal gradients increase. (2) The failure volumetric strain change to expansion from shrinking gradually accords with the increase of the thermal gradients (or the thermal increase) under different confining pressures. (3) The strength decreases as the thermal gradients increase at the same confining pressure, and that increases firstly then decreases as the confining pressure increases under different thermal gradients, the reason for which can be attributed to the ice thawing and the fissure extension. (4) The compression strength under different thermal gradients can be described by the modified linear yielding criteria set up in the homogenous thermal field.

Keywords: frozen clay thermal gradient failure mode compression strength weakening inhomogenous effect

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