

目次

冻土材料非线性断裂模型的试验研究

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摘要 冻土是多相体复合材料, 土体冻结过程中在内部形成空穴、裂隙等多种缺陷。把这些缺陷简化为冻土中的初始裂纹, 应用断裂力学理论和试验方法, 研究冻土的非线性断裂过程和特征。结果表明: 冻土非线性断裂破坏过程由弹性阶段、微裂纹损伤区形成阶段和软化阶段组成, 其中微裂纹损伤区形成阶段是冻土非线性破坏的主要表征。把微裂纹损伤区简化为假想裂纹处理, 可称为虚拟裂纹, 并考虑冻土中冰晶体胶结力作用, 给出冻土非线性断裂破坏的胶结力裂纹模型; 讨论胶结力的性质与分布, 给出微裂纹损伤区长度确定的方法, 为理论分析与数值计算提供依据。同时, 还对胶结力裂纹模型涉及的非线性断裂韧性指标 dC 进行测试, 给出相应测试方法和结果。

关键词 [土力学](#) [冻土](#) [非线性断裂破坏](#) [微裂纹损伤区](#) [断裂韧度](#)

分类号

EXPERIMENTAL STUDY ON NONLINEAR FRACTURE MODELS OF FROZEN SOIL

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Abstract

Frozen soil is a kind of multi-phase compound material. There are many defects and micro-cracks in frozen soil. Supposing the defects as the initial crack, using the theory and testing method of fracture mechanics, the nonlinear fracture process and character of frozen soil are investigated. The result shows that the nonlinear fracture process of frozen soil is composed of elastic period, micro-crack damage zone(MDZ) forming period and softening period. MDZ forming period is the main feature of nonlinear failure of frozen soil. The micro-crack is regarded as the virtual crack, considering the cement ice in frozen sold, the cementation force crack model of nonlinear fracture failure is presented. The material in MDZ is partially damaged but still able to carry cementation stress, which is nonlinearly distributed over the length of MDZ. Then the method to calculate the length of MDZ is proposed. This model can offer some references for theory analysis and numerical calculation. Finally, the test method of nonlinear fracture toughness index involved in cementation force crack model and the corresponding results are given.

Key words [soil mechanics](#) [frozen soil](#) [nonlinear fracture failure](#) [micro-crack damage zone\(MDZ\)](#) [fracture toughness](#)

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