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# 基于修正Masing准则的萧山软黏土动应力 - 应变关系研究

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**摘要** 地震、波浪、交通等不排水循环荷载的作用将引起土体孔隙水压力上升, 从而使土体的刚度、强度发生软化现象, 以往对软黏土动应力 - 应变关系的研究大都忽略循环软化的影响。采用 Masing 准则及其修正来描述软黏土的动应力 - 应变关系往往与实际偏差较大, 主要是因为该准则未能考虑软黏土的循环软化特性。通过对萧山软黏土进行应力控制的循环三轴试验, 研究循环次数、循环应力、偏应力对萧山软黏土的循环软化特性的影响。通过对每次循环中的刚度进行无量纲化得到量纲一的刚度  $G_{sec}/G_{max}$  与循环应变幅值的关系曲线。研究表明, 当循环应力较小时,  $G_{sec}/G_{max}$ - 曲线由硬化及软化两部分组成; 当循环应力大于 58 kPa 时, 该曲线仅表现为软化特性。在试验基础上得到量纲一的刚度软化模型, 该模型可体现每次循环过程中的刚度软化规律。同时, 基于修正的 Masing 准则, 结合循环软化模型, 得到考虑循环软化特性的萧山软黏土动应力 - 应变关系曲线。

**关键词:**

关键词 [土力学](#); [循环荷载](#); [Masing 准则](#); [萧山软黏土](#)

分类号

## STUDY ON DYNAMIC STRESS-STRAIN RELATIONSHIP OF XIAOSHAN SOFT CLAY BASED ON MODIFIED MASING RULES

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### Abstract

Earthquakes, waves and traffic often induce severe undrained cyclic loading. Degradation of stiffness and strength will occur in soft clay under cyclic loading because of the generation of pore water pressure. Unfortunately, previous work rarely incorporated the effect of cyclic degradation behavior on dynamic stress-strain relationship of soft clay. The Masing rules, often used in modelling the behavior of soils under cyclic loading, are unreliable when there is significant cyclic degradation of the stress-strain curves. The cyclic degradation characteristics of normally consolidated Xiaoshan soft clay subjected to undrained cyclic triaxial loading are investigated at different numbers of cycles, cyclic stress level and initial deviator stress. The variation of normalized stiffness  $G_{sec}/G_{max}$  with variation amplitude of axial strain under different loading conditions in each unload-reload loop is presented. It can be observed that when the cyclic stress is smaller, the curves of  $G_{sec}/G_{max}$ - are composed of two parts, one for hardening and the other for softening. There is only the decreasing part left to the curves when the cyclic stress is larger than 58 kPa. An empirical degradation model for Xiaoshan soft clay is also proposed by normalizing the secant shear modulus in each unload-reload loop. The model takes account of the degradation behavior of soft clay inside a cycle. Based on the degradation model, concepts of Masing rules are modified to model the stress-strain behavior of Xiaoshan soft clay.

**Key words** [soil mechanics](#); [cyclic loading](#); [Masing rules](#); [Xiaoshan soft clay](#)

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