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两种边界条件下非饱和土一维固结特性分析

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One-Dimensional Consolidation Behavior of Unsaturated Soils under Two Boundary Conditions

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- 摘要
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摘要 针对工程中存在的表面排气不排水、底面不渗透及表面排水不排气、底面不渗透两种边界条件下的非饱和土层进行一维固结特性研究.基于Fredlund非饱和土一维固结理论，对其固结方程作适当假定，由得到的液相及气相控制方程、Darcy定律及Fick定律，经Laplace变换和Cayley Hamilton定理构造顶面状态向量与任意深度处状态向量间的传递关系.通过引入边界条件，得到Laplace变换域内的超孔隙水压力、超孔隙气压力及土层沉降的解.采用Crump方法编制程序实现Laplace逆转换，得到时间域内的超孔隙水压力、超孔隙气压力、土层沉降的半解析解.采用典型算例，分析在不同气相与液相渗透系数比情况下，土体超孔隙水压力、超孔隙气压力随时间的变化规律，结果对非饱和土体一维固结特性研究具有参考价值.

关键词： 一维固结 非饱和土 超孔隙水压力 超孔隙气压力 固结度

Abstract： Aiming at the engineering practice in special circumstances, one-dimensional consolidation of unsaturated land-based issues under compression is studied considering the boundary conditions that the surface is air infiltration water impermeable and the underside is impermeable. Based on the one dimensional consolidation theory of Fredlund unsaturated soils, appropriate assumptions are made. Applying Laplace transform and the Cayley Hamilton theorem to the liquid and vapor control equations, and Darcy’s law and Fick’s law, the transfer function between top of the state vector and any depth of the state vector is constructed. By introducing boundary conditions, excess pore water pressure and excess pore air pressure are derived in the Laplace domain. Using the Crump method, inverse Laplace transform is performed, and a semi-analytical solution to the excess pore water pressure and excess pore air pressure obtained in the time domain. Typical examples are given to show changes in excess pore air pressure, excess pore water pressure and degrees of consolidation with the time under different conditions of air water coefficient rate of penetration. These results are useful for the research of characteristics of unsaturated soils one-dimensional consolidation.

Keywords： one-dimensional consolidation， unsaturated soil， excess pore water pressure， excess pore air pressure， degree of consolidation

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