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岩土力学与地基基础

吹填软土一维大变形自重固结的有限差分数值解

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Finite difference numerical solution of one-dimensional large strain and#br# self-weight consolidation of dredged-fill soil

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摘要 吹填软土发生自重固结的物理本质在于超孔隙水压力的消散与有效应力的增长，以往有关土体大变形自重固结问题的求解方法多基于Gibson大变形固结理论，未从物理本质上反映土体的固结过程。文章基于Gibson大变形固结理论的有关假定，推导建立以超孔隙水压力为变量的一维大变形自重固结控制方程，该方程的形式简单，系数的物理意义明确。结合吹填软土自重固结的边界条件及初始条件，采用修正隐式差分格式的有限差分法求解得到方程的有限差分数值解，该数值解能够求解任意e-σ′和e-k函数关系下吹填软土的自重固结过程。通过与Lee和Sills求得的解析解及SWC模型解对比，从超孔隙水压力、孔隙比及沉降3个方面对数值解的正确性进行验证。利用文章所提方法分析初始厚度、初始孔隙比及土粒比重对自重固结性状的影响。分析表明，土体自重固结过程中的沉降固结度始终大于孔压固结度，初始厚度对孔压固结度的影响更大，初始孔隙比及土粒比重对沉降固结度的影响更大。

关键词： 吹填软土, 自重固结, 数值解, 孔压固结度, 沉降固结度

Abstract: The dissipation of the excess pore water pressure and the increase of the effective stress are the physical essence of the self-weight consolidation of dredged fill soil. However, in the past, the solutions to the problem of large strain and self-weight consolidation of the soil are mostly based on the Gibson's large strain consolidation theory, which does not reflect the consolidation process of the soil physically. In this paper, based on the assumptions in Gibson's large strain consolidation theories, a governing equation of one-dimensional large strain and self-weight consolidation with excess pore water pressure as a variable is derived. The governing equation is simple in form and the physical significance of the coefficient is clear. By introducing the modified implicit difference scheme, the finite difference numerical solution of the governing equation is obtained by using the finite difference method with the boundary conditions and initial conditions of the self weight consolidation of dredged-fill soil. The numerical solution can solve the self-weight consolidation process of dredged-fill soil under arbitrary e-σ′ and e-k relationship. The excess pore water pressure, void ratio and settlement obtained with the analytical solution using the Lee & Sills and the solution of SWC model agree well with those by the proposed method, which validates the the numerical solution. The influences of the initial thickness, the initial void ratio and the specific gravity on the large strain and self-weight consolidation behaviors are further analyzed by using the method proposed in this paper. The analysis results show that the consolidation degree defined by settlement in the consolidation process is always greater than that defined by the stress. The initial thickness influence much on the stress consolidation degree, while the initial void ratio and the specific gravity have a greater influence on the settlement consolidation degree.

Key words: dredged-fill soil self-weight consolidation numerical solution stress consolidation degree settlement consolidation degree

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