非饱和砂质海床在复合防波堤下固结的数值研究

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CONSOLIDATIION OF 2-D POROUS UNSATURATED SEABED UNDER A COMPOSITE BREAKWATER

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摘要 本文以Biot动态方程(u-p公式)为控制方程,采用有限元方法和Generalized Newmark-β时间积分方法,在SWANDYNE的基础上发展了用于分析海床基础固结和动态响应分析的计算程序PORO-WSSI 2D。利用太沙基一维固结理论验证了POR-WSSI 2D中固结模块的有效性。利用该计算程序,深入研究了大型海床基础在大型复合式防波堤和静水压力作用下的固结过程以及最终的固结状态。计算结果表明计算程序PORO-WSSI 2D能够有效地分析评价海床基础在海洋结构物作用下的固结过程以及预测海床基础的剪切破坏行为。所确定的最终固结状态还可以为后续研究海床基础在波浪、地震等动力荷载作用下的动态液化和剪切破坏提供可靠的初始条件。

关键词: 固结沉降 Biot理论 非饱和海床 孔隙介质 复合式防波堤 剪切破坏 液化

Abstract: This paper uses the Dynamic Biot's equation as the governing equation, and adopts the finite element method for space discretization and the generalized Newmark-β for time discretization. A computational program PORO-WSSI 2D is developed for the consolidation and dynamic response analysis of seabed foundation. It is based on the program SWANDYNE which is for earthquake analysis. The consolidation modulus in PORO-WSSI 2D is validated by the Terzaghi 1D consolidation theory. Applying the PORO-WSSI 2D,the consolidation process and the final consolidation status of seabed foundation under a large-scale composite breakwater and hydrostatic water pressure are intensively investigated. The computational results indicate the PORO-WSSI 2D can effectively analyze and evaluate the consolidation process, and predict the shear failure of seabed foundation under marine structures.the final consolidation status determined also can provide the initial conditions as true as possible for the later analysis of liquefaction and shear failure in seabed foundation under the ocean wave or earthquake loading in engineering.

Key words: Consolidation Subsidence Composite breakwater Biot's theory Unsaturated seabed Porous media Shear failure Liquefaction

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