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论文

基于Boussinesq方程的波浪模型

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摘要 从欧拉方程出发，提供了另一种推导完全非线性Boussinesq方程的方法，并对方程的线性色散关系和线性变浅率进行了改进. 改进后方程的线性色散关系达到了一阶Stokes波色散关系的Pad\'{e}[4,4]近似，在相对水深达1.0的强色散波浪时仍保持较高的准确性，并且方程的非线性和线性变浅率都得到了不同程度的改善. 方程的水平一维形式用预估-校正的有限差分格式求解，建立了一个适合较强非线性波浪的Boussinesq波浪数值模型. 作为验证，模拟了波浪在潜堤上的传播变形，计算结果和实验数据的比较发现两者符合良好.

关键词 Boussinesq模型 色散关系 波浪变形 浅水 表面水波

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A wave model based on the boussinesq equations

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Abstract

An alternative method to derive a set of fully nonlinear Boussinesq equations up to the order of $O(\mu^{2}$, $\varepsilon^3 \mu^{2})$ is presented. The linear dispersion relation and the shoaling gradient of the equations are improved by adding some dispersive terms. The linear dispersion relation of the enhanced equations is the Pad\'{e} [4,4] expansion of the linear Stokes dispersion relation, the accuracy of which is acceptable even when the relative water depth is as large as 1.0. Its nonlinear property and shoaling gradient are also improved. The horizontal one-dimensional equations are solved with a predictor-corrector finite difference scheme and a fully nonlinear Boussinesq wave model is established, which enjoys high computational efficiency and reliability. The numerical model is verified by simulating the transformation of waves propagating over a submerged bar. The numerical results are verified against the laboratory experimental data, and their agreement is found to be very good.

Key words Boussinesq model dispersion relation wave transformation shallow water surface water wave

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