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中文题名	斜对角笛卡尔方法在平面二维水沙数学模型中的应用
英文题名	Study Cases of Diagonal Cartesian Method for Two-dimensional Mathematical Model of Flows and Suspended Sediment Transport
中文关键词	斜对角笛卡尔方法;二维水沙数学模型;模型应用
英文关键词	diagonal Cartesian method;two-dimensional flow and sediment transport modeling;study case
中文文摘	在工程水力学及工程泥沙研究的数学模型中，处理好复杂边界以及干湿动边界将直接影响到整个模型计算结果的可靠性、精度和计算时间，一直是人们关心的重点。选择复杂边界以及干湿动边界的处理方法与数值计算方法的选择有着同等重要性。本论文采用斜对角笛卡尔坐标方法对不规则的复杂边界进行模拟，重点处理好干湿动边界的变化，并在斜对角笛卡尔坐标系中进行二维浅水运动的水流泥沙基本控制方程的离散和数值计算求解。 模型为非耦合及非饱和输沙模型，恒定和非恒定情况都可以计算。数值计算方法采用 ADI 方法，离散时采用迎风格式；计算网格采用正交均匀网格；利用斜对角笛卡尔坐标方法模拟不规则的复杂边界时，结合了动边界处理技术对边界的动态变化加以追踪。 论文将斜对角笛卡尔坐标方法平面二维水沙数学模型应用于福建泉州湾潮流泥沙计算、北京小中河洪水演进计算、长江镇江段泥沙与油污扩散计算、北京永定河跨河桥阻水计算、辽宁大东沟蓄水库淤积计算和北京十三陵水库风生流及泥沙扩散计算等六个实际工程项目的研究中，并针对各个工程相应添加了计算取排水、排沙、油污扩散和风力影响的模块。将计算所得的流场和泥沙浓度场与实测资料进行了比较验证，在此基础上进一步计算分析了自然条件（如大、中、小潮的涨落潮，各种频率的洪水，不同风向、风速，风暴潮等）和人工条件（包括围垦、建港、架桥、工程取排水、泄沙、施工船舶排放含油污水等）等多种工矿下工程区域的水流运动、泥沙输移及污染物扩散的规律，为相应工程建设的决策和优化提供了科学的依据。 通过以上在实际工程中的应用和相应实测资料的验证，表明在平面二维水沙计算中采用斜对角笛卡儿方法结合干湿动边界处理技术，能很好地模拟实际边界及其动态变化，不仅拟合误差小、避免产生锯齿状边界，而且进行编程计算时处理简单、附加计算量小、计算效率高。该方法为复杂边界问题的计算提供了一种新的思路，具有较好的应用前景。
外文文摘	On the study of mathematical model for engineering hydraulics and sediment transport research, the complex dynamic boundary is the key point for the calculations, which will directly impact the reliability, accuracy and calculation time of the whole calculation results. To choose the treatment method for the complex dynamic boundary is as important as to choose the numerical method. In this paper, the diagonal Cartesian method simulating the complex boundary, together with the treatment to wetting-drying dynamic variation of the boundary, is applied into the two-dimensional shallow-water flows and sediment transport mathematical modeling, and their governing equations are discretized and solved in diagonal Cartesian coordinates. The model is non-coupling and non-saturating sediment transport, and it can calculate steady and unsteady flow. It adopts ADI method as the numerical method, upwind format when discretizing the equations, orthogonal and uniform mesh as calculation mesh, and special processing program when tracing the dynamic boundary. The study cases of the model with the diagonal Cartesian method have calculated the tidal and sediment transport of Quanzhou bay in Fujian province, the flood development of Xiaozhong river in Beijing, the sediment transport and pollutant diffusion of the Yangtze River segment at Zhenjiang in Jiangsu province, the blocking influence on flow due to the bridge across Yongding river in Beijing, the sediment deposition of the reservoir at Dadonggou in Liaoning province, and the flow and sediment transport due to wind of 13-tombs reservoir in Beijing. And the modular programming is added into the original program to calculate fetching or draining water, sediment or pollutant discharge, and wind influence correspond to the requirement of the engineering. The calculated results such as flow field and the distribution of sediment concentration are verified by the measure data, and further calculation and analysis is on the laws of flow movement, suspended

	sediment transport and pollutant diffusion in research regions under various natural (such as flood and ebb tides of various ranges, floods of various frequencies, winds of various directions and velocities, storm surge, etc.) and man-made conditions (including beach inning, port and bridge buildings, engineering acquirement for water, sediment discharge, oil leakage of ships, and so on), providing scientific foundation for the decision-making and optimization of corresponding engineering constructions. Through the applications and verifications in the engineering projects above, it shows that in the two-dimensional flow and sediment transport calculation, the diagonal Cartesian method, together with the dynamic boundary treating method, can simulate the actual boundary and its dynamic variation well, with small error and avoiding saw-tooth boundary; with simple treatment of program design, low quantity of additional calculation, and high calculating efficiency. This method provides a new idea for the complex dynamic boundary calculation and good application prospect.
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