产品类成果

水库淤积与河床演变通用数学模型

【创新性】

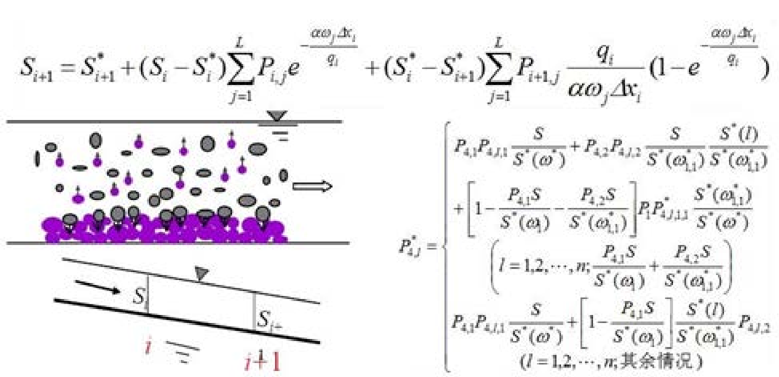
具有坚实理论基础，包括非均匀悬移质不平衡输沙理论，含沙量与其级配及床沙级配之间的关系；挟沙能力级配及有效床沙级配的概念及一般条件下表达式；异重流的潜入条件补充及不平衡输沙和挟沙能力关系，浑水水库的形成；宽级配推移质不平衡运动理论；淤积物密实过程和干容重变化机理；冲淤过程中的糙率变化等。计算内容详尽，能给出沿程水位、流速、流量、含沙量、悬移质和床沙级配、冲淤量、冲淤厚度等泥沙输移及河床演变的各种参数信息，能合理反映实际河流中泥沙级配沿程分选及床沙粗化和细化过程。通用性强，从微米级到米级的各级粒径泥沙基于统一的理论基础，没有待定系数和关系式。适用范围广，先后经过丹江口水库、葛洲坝水库、三门峡水库、丹江口水库下游汉江冲刷、长江及黄河天然河道冲淤的验证。计算稳定，对金沙江四个水库及三峡库联合运行情况已计算 300 年，结果十分合理。

【影响力】

本模型是建立最早、泥沙计算最详细、理论基础深厚、长期应用不衰的一维泥沙数学模型，起源于 20 世纪 60 年，至今仍在发展。2008 年由水利水电规划设计总院和水电水利规划设计总院组织编写的《水利动能设计手册》泥沙分册对这个模型进行了较详细的介绍。在此之前，本模型泥沙部分的主要内容已收入教科书中。模型中的一些泥沙关系，广泛被其他模型应用。目前，通用数学模型已大量应用于各类泥沙问题的解决，包括水库淤积、河道冲淤演变、河口海岸演变、取排水口附近冲淤、引航道和港池回淤等。其强大功能和可靠性已被包括三峡、小浪底等上百座水库，长江下游、黄河下游等几十条河流实测资料所证实。该成果 1986 年获得全国计算机应用一等奖，1988 年获得水电部科技进步二等奖、国家科技进步三等奖。

主要完成人：韩其为、何明民

受奖单位：泥沙所



GENERAL MATHEMATICAL MODEL FOR RESERVOIR SEDIMENTATION AND RIVERBED VARIATION

【Innovation】

The model has solid theoretical foundation, including the theory of non-equilibrium transport of non-uniform suspended sediment, the relationship between sediment concentration and its gradation and bed-load gradation; the concept and expression of gradations of sediment carrying capacity and efficient bed-load; the supplement of dive conditions for density currents, the relationship between non-equilibrium sediment transport and sediment carrying capacity, and the formation of turbid water reservoirs; the theory of non-equilibrium transport for bed load with wide size gradation; the dry density mechanism and compaction process of sedimentation; the change of roughness during erosion and deposition, etc. The calculation is detailed, and it can tell such rich longitudinal parameters as water level, velocity, discharge, sediment concentration, size gradation for both suspended sediment and bed material, quantity of erosion and deposition, bed variation and so on, and therefore it could reasonably reflect longitudinal change of suspended sediment gradation and the coarsening and refining process of bed material in actual rivers. The model has strong generality, and the sediments with size from micron to meter are based on a unified theoretical basis, without undetermined relationships and coefficients. It enjoys a wide range of applications, and it has been successively verified by the Danjiangkou Reservoir, the Gezhouba Reservoir, the Sanmenxia Reservoir, scouring of Hanjiang River in the lower reaches of the Danjiangkou Reservoir, as well as scouring and silting of Yangtze River and Yellow River. The calculation is stable, and it has been used to calculate the future 300-year sedimentation process for the joint operation of four reservoirs in the lower Jinsha River and the Three Gorges Reservoir, and the result is very reasonable.

【Influence】

This model is the earliest-built one-dimensional sediment mathematical model that boasts the most detailed sediment calculation, profound theoretical foundation and long-term application. It originated in the 1960s, and is still developing today. The Sediment Series of the Hydraulic Kinetic Design Handbook, which was compiled by the General Institute of Water Planning of Ministry of Water Resources and the China Renewable Energy Engineering Institute in 2008, gives a detailed introduction to the model. Prior to it, the main content of the sediment part of this model had been already included in textbooks. Some sediment relationships of the model have been widely used by other models. At present, the general mathematical model is widely used to solve various kinds of sediment problems, including reservoir sedimentation, the erosion and deposition of riverbed, the estuary and coastal evolution, scouring and silting close to water intakes, sedimentation in approach channel and harbor base. Its powerful functions and reliability have been verified by measured data from a few hundred reservoirs such as Three Gorges and Xiaolangdi and from a few dozen rivers, such as the lower reaches of Yangtze River and Yellow River. The achievement has won the first prize of the national computer application competition in 1986, the second prize of the science and technology progress award granted by the former Ministry of Hydropower, and the third prize of the National Science and Technology Award in 1988.

Main Contributor : Han Qiwei, He Mingmin

Award-winning Unit : Department of Sediment Research