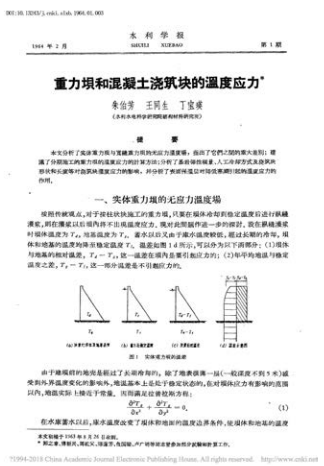
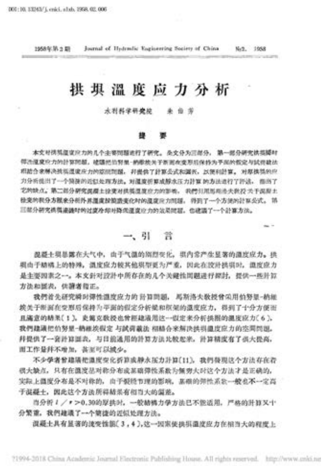
基础类成果

水工混凝土温度应力的研究

RESEARCH ON THERMAL STRESS OF HYDRAULIC CONCRETE


重力坝和混凝土浇筑块的温度应力


拱坝温度应力分析

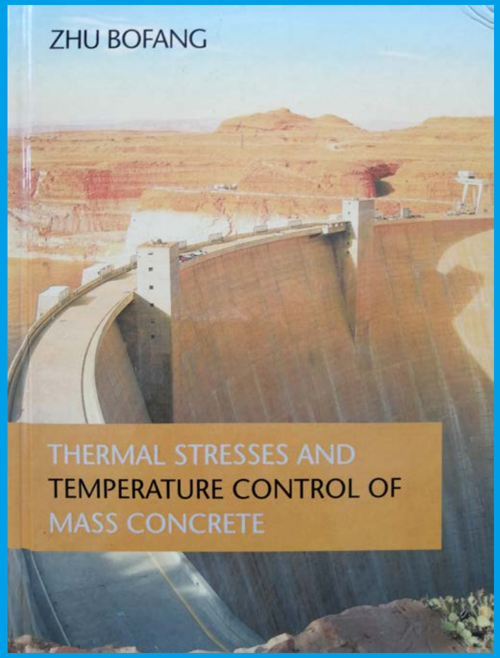
【创新性】

首次建立非均匀质粘弹性体徐变理论，提出并证明非均质弹性徐变体在混合边界条件下的两个基本定理，解决了非均质结构徐变对结构应力的影响问题；首次阐明了水工混凝土温度应力发展的基本规律并提出混凝土浇筑块、弹性地基梁、重力坝、拱坝、船坞、孔口、库水温度、寒潮等一系列解析算法，解决了水工混凝土结构规范中求解温度应力的难题；首次提出水工混凝土温度徐变应力分析的隐式解法、子结构法和简谐徐变应力分析等效模量法，大幅度提高了有限元法计算温度应力的计算精度和求解效率；提出水工混凝土弹性模量、绝热温升、徐变度、应力松弛系数等计算公式，解决了水工混凝土结构规范中计算混凝土热力学参数的难题。

【影响力】

在我国开辟了混凝土徐变理论和混凝土温度应力等研究领域，阐明了水工混凝土的基本规律、计算方法和控制技术，使我国水工混凝土温控防裂措施实现了从定性认识到定量分析的跨越；提出的混凝土浇筑块、基础梁、重力坝、拱坝、船坞、寒潮、库水温度、冷却水管等一系列算法广泛应用于实际工程，其中 9 项已纳入我国重力坝、拱坝、船坞结构等设计规范及水工设计手册；提出的水工混凝土弹性模量、绝热温升、徐变度、应力松弛系数等热力学参数计算公式已列入我国混凝土结构规范规程；提出的混凝土温度徐变应力分析的隐式解法及子结构法等应用于我国有限元温度仿真分析软件中；获得 1982 年度国家自然科学三等奖。

主要完成人：朱伯芳、王同生、丁宝瑛、郭之章
受奖单位：水电中心 / 结构材料所



【Innovation】

It initially established the anisotropic, viscoelastic creep theory, and put forward and proved two fundamental theorems under mixed boundary conditions for anisotropic, elastic creep properties, which has addressed the issue of the impact of anisotropic structural creep on the structural stress; clarified the basic rules of thermal stress development of hydraulic concrete and came up with a series of analytic algorithms for concrete blocks, elastic foundation beams, gravity dams, arch dams, docks, orifices, water temperature of reservoirs and cold waves, and solved the thermal stress difficulty in the hydraulic concrete structure specification; initially proposed the implicit method, the substructure method and the equivalent modulus method for the simple harmonic analysis of creep stress for the thermal creep stress analysis of hydraulic concrete, which has remarkably improved the computational accuracy and efficiency of thermal stress calculated by the finite element method; put forward the calculation formulas for elastic modulus, adiabatic temperature rise, degree of creep and stress relaxation coefficient of hydraulic concrete, which has solved the problem for the calculation of the thermodynamic parameters of concrete in hydraulic concrete structure specification.

【Influence】

It opened up the field of research on the concrete creep theory and concrete thermal stress in China, and clarified the basic rules, calculation method and control technology of hydraulic concrete, thus helping China's hydraulic concrete temperature control and cracking prevention measures achieve a shift from qualitative understanding to quantitative analysis; came up with a series of algorithms for concrete blocks, basic beams, gravity dams, arch dams, docks, cold waves, water temperature of reservoirs and cooling water pipes, enjoying widespread application in practical projects, with nine listed into China's design specification and hydraulic design manuals of gravity dams, arch dams and dock structure; put forward various formulas for the calculation of thermodynamic parameters, such as elastic modulus, adiabatic temperature rise, degree of creep and stress relaxation coefficient of hydraulic concrete, which have been listed into China's concrete structure specification; proposed the implicit method and the substructure method for the analysis of concrete temperature creep stress, which have been applied in the country's finite element temperature simulation analysis software; won the third prize of the National Natural Science Awards in 1982.

Main Contributor : Zhu Bofang, Wang Tongsheng, Ding Baoying, Guo Zhizhang
Award-winning Unit : Research Center for Sustainable Hydropower/Department of Structures and Materials