2018

ANNUAL REPORT

IWHR 60 1958–2018

China Institute of
Water Resources and
Hydropower Research
中国水利水电科学研究院

ANNUAL REPORT

IWHR

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KUANG Shangfu, Ph.D.
President of IWHR

The year 2018 is undoubtedly an unusual year for IWHR as it marks the 40th anniversary of China's adoption of Reform and Opening-up Policy and the 60th anniversary of IWHR, which is more special to the Institute itself. In Chinese culture, 60 decades is called a Jiazi which means a cycle of development and is therefore of special significance. During the sixty years of development, IWHR people have worked with all our efforts to pursue the prosperity of the nation and happiness of the people, bearing this in mind as our mission and responsibility as we went ups and down with the country. We have proudly interpreted with our own action the philosophies that "Strong science and technology make strong country" and that "Only leading country produces leading academics".

Firmly adhering to the decision and deployment of the central government, IWHR has been growing and evolving over the 60 years. In 1958, it was established as a national team for water resources and hydropower research by merging three high-level research institutes at that time respectively under the Chinese Academy of Sciences, the Ministry of Water Resources and the Ministry of Electric Power Industry. Since the reform and opening-up policy was adopted in China in the late 1970s, focusing on the national needs while learning the advanced experience from home and abroad, IWHR has strongly supported the rapid socio-economic growth and guaranteed the water security of the nation by constantly optimizing its business layout, improving its disciplinary structure and building up its strength. As we ushered in the 21st century, in line with the adjusted national development strategies, IWHR proposed the development strategy shortened as "1 goal, 2 priorities, 3 capacities, 4 bases, 5 developments and 6 excellences", officially starting its new journey towards a world's top-notch research institute. Entering the new era when President Xi Jinping has put forward the "three-step" strategy to build China into a strong country of science and technology, IWHR has more explicitly elaborated its development goals of three phases: to join the club of world-class research institutes of water resources and hydropower by 2020, to become one of the best in the club by 2035, and to lead the club by 2050.

Over the 60 years, bearing the unswerving ambition to make the country prosperous and the people rich and happy, generations of IWHR people have devoted themselves to research and innovation regardless of any kind of difficulty. As the leading research institute for a host of national key research programs, IWHR has undertaken the research and consultancy work for almost all the main water resources and hydropower projects in China, solving a series of major science and technological challenges, and thus making significant contributions to the technical progress and rapid development of China's water resources and hydropower sector. The enormous work has helped the Institute nurture a large number of talented people, including 12 academicians of both Chinese Academy of Sciences and Chinese Academy of Engineering and a stable pool of 1,400 researchers and scholars, and reap innumerable achievements including more than 700 research achievements with great

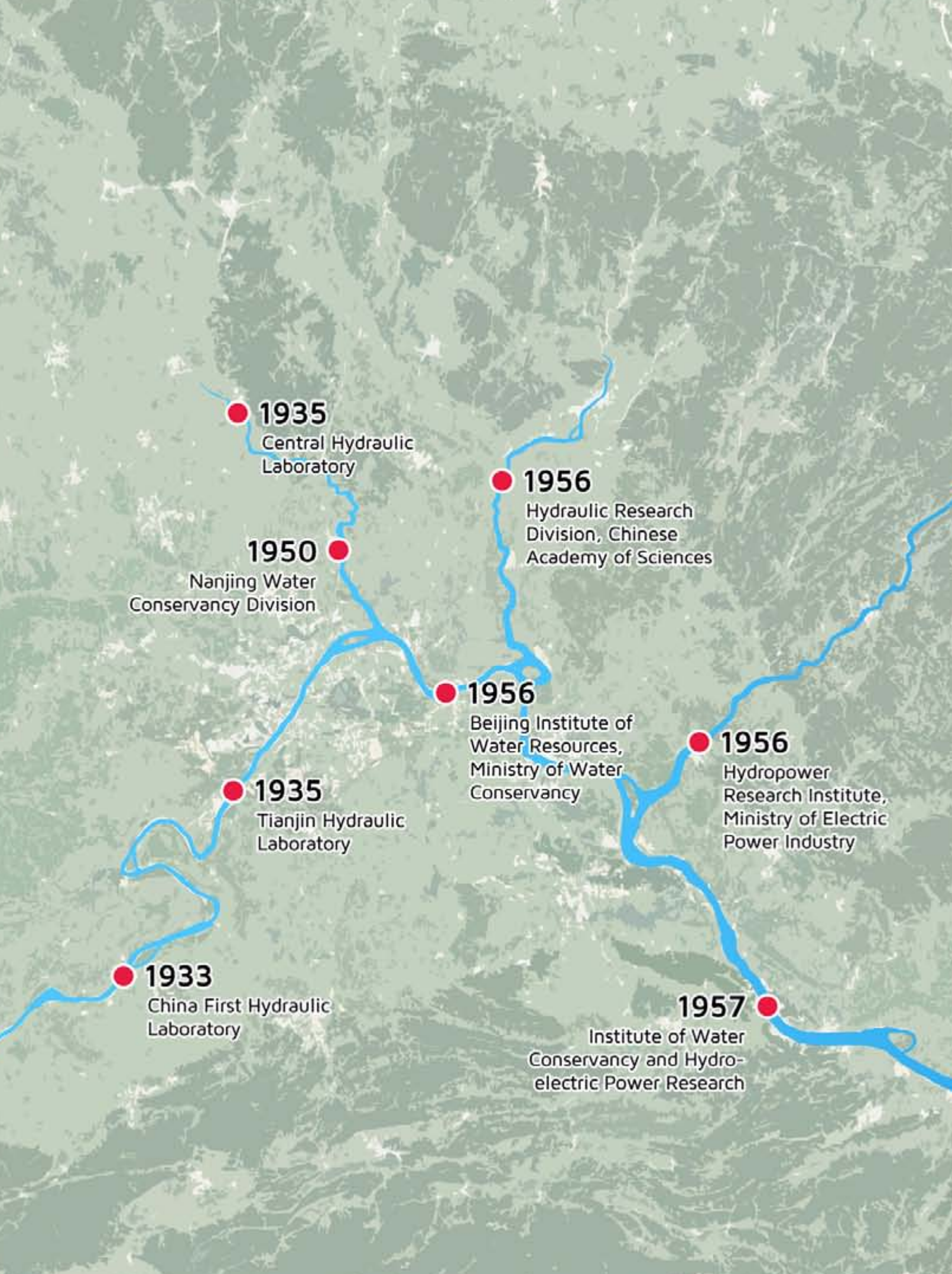
WELCOME MESSAGE

originality recognized by national and provincial prizes. Covering 18 research disciplines and 93 research directions now, IWHR has established 4 national and 8 ministerial research centers, 1 state key laboratory and 2 ministerial key laboratories, representing China's largest research center and training base of water resources and hydropower with the most complete disciplines and best research conditions.

Over the 60 years, IWHR has always been aiming high with global vision. As China keeps rising, IWHR has accelerated its international cooperation and exchange and made remarkable achievement. IWHR has established cooperative relationship with over 100 foreign academic organizations and overseas research institutes and universities. It is now the host of multiple international water-related organizations or their Chinese branches, including the World Association for Sedimentation and Erosion Research (WASER), and the World Association of Soil and Water Conservation (WASWAC), the International Association for Hydro-Environmental Engineering and Research (IAHR), the International Conference on Flood Management (ICFM), the International Commission on Large Dams (ICOLD), the International Commission on Irrigation and Drainage (ICID), the Global Water Partnership (GWP), the International Hydropower Association (IHA), and the Asia River Restoration Network (ARRN). With 12 experts serving as the honorary president, vice chair or secretary general in ICOLD, ICID, IAHR and others, IWHR has organized many international academic conferences with far reaching influence, including the ICOLD Annual Meeting, the IAHR World Congress, the International Conference on Flood Management, and the World Hydropower Congress to name a few. IWHR has also consulted for numerous international water and hydropower projects in Asia, Africa, Europe and Americas, strongly supporting China to go global in the water sector.

History always gives people the opportunity to draw wisdom and the power to move forward on some particular occasions. In 2018, as part of the celebration of its 60th anniversary, IWHR organized a series of academic activities for a whole week, exhibiting the institute's achievement, communicating the water governance cases from different countries, discussing water challenges of different regions, and sharing the new concepts and technologies for water management. Leaders of international organizations, renown experts from China and abroad, academicians and governmental officials were invited to the events to share our joy, exchange views and solutions and inspire all participants. I am most grateful for the support of all our friends who have joined us in this great event in Beijing. My sincere gratitude also goes to those who have always cared and supported IWHR along its development but were unable to make it to the event due to whatever reasons.

Looking ahead, we will build on our existing efforts and hold the hands of our international partners more firmly on the joint adventure to the future to create new wonder in this new era!


1935
Central Hydraulic Laboratory
1950
Nanjing Water Conservancy Division
1956
Hydraulic Research Division, Chinese Academy of Sciences
1956
Beijing Institute of Water Resources, Ministry of Water Conservancy
1935
Tianjin Hydraulic Laboratory
1956
Hydropower Research Institute, Ministry of Electric Power Industry
1933
China First Hydraulic Laboratory
1957
Institute of Water Conservancy and Hydro-electric Power Research

HISTORY

Annual Report
2018

CHINA INSTITUTE OF WATER RESOURCES AND HYDROPOWER RESEARCH

IWHR IN MAPS

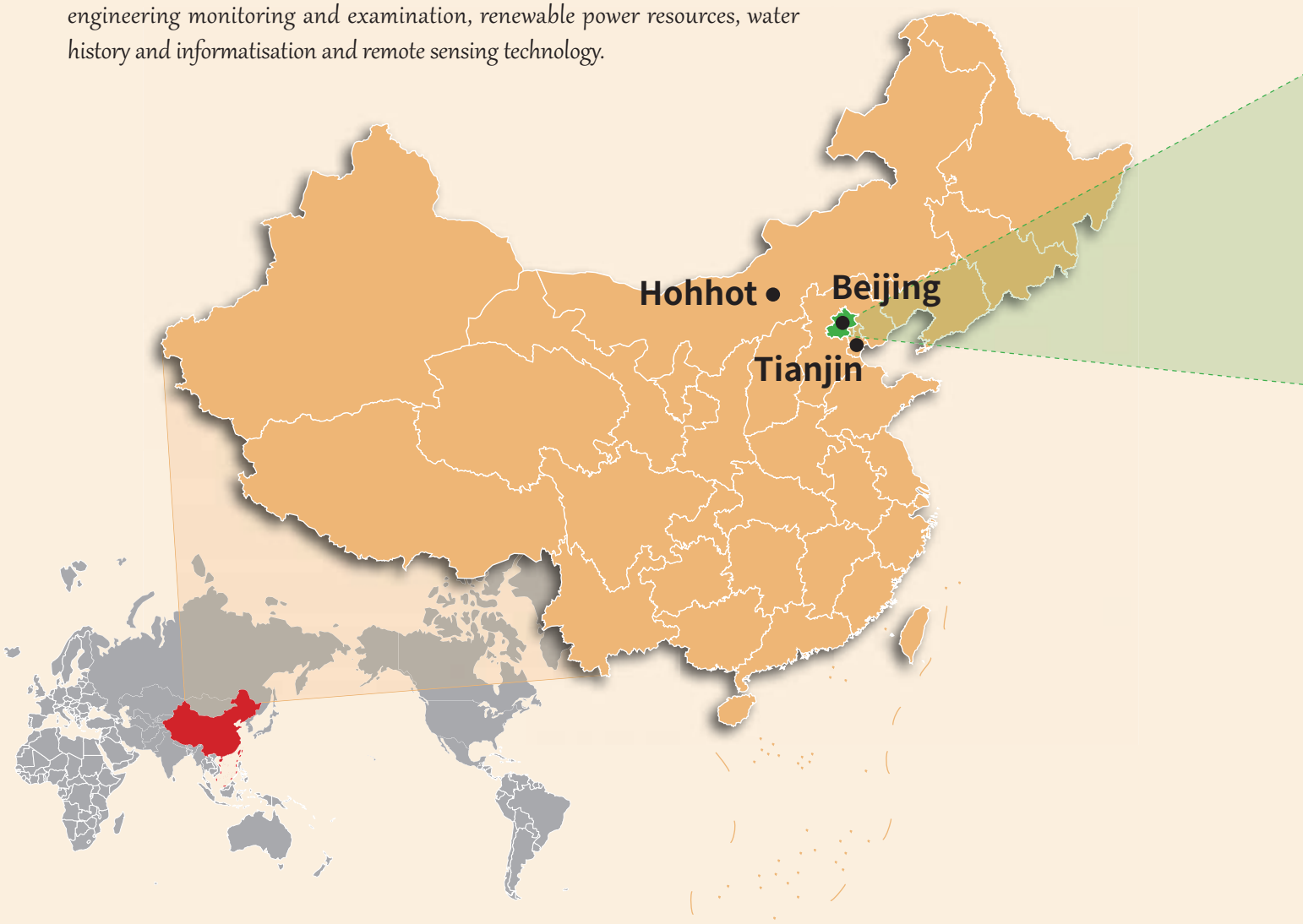
China Institute of Water Resources and Hydropower Research (IWHR) is a national research institution under the Ministry of Water Resources of China, and is engaged in almost all the disciplines related to water resources and hydropower research.

With over 60 years of development, IWHR has grown into an indispensable think tank of the Chinese government for decision making and a backbone technical consultant in water related areas. It is at the same time the host of multiple international organisations or their Chinese branches, including WASER, WASWAC, IAHR, ICFM, ICOLD, ICID, IAHR, GWP, IHA and ARRN.

With 11 research departments and four affiliated enterprises, IWHR is endowed with research capacity in: hydrology and water resources, water environment and ecology, flood control, drought relief and disaster reduction, soil and water conservation, river and lake management, water resources in rural and pastoral areas, hydraulics, geotechnical engineering, hydraulic structures and materials, earthquake engineering, hydro machinery and electric equipment, automation, engineering monitoring and examination, renewable power resources, water history and informatisation and remote sensing technology.

Department of Water Resources for Pastoral Areas (**Hohhot**, Inner Mongolia)

Tianjin Institute of Hydroelectric and Power Research (**Tianjin**)



The map of Beijing here is modified from Beijing Tourist Map (2016) by © Beijing Municipal Commission of Tourism Development

Scan to find IWHR (South) in **Google Maps**

Scan to find IWHR (South) in **Baidu Maps**

IWHR (South)

IWHR (North)

Daxing Experimental Base

Yanqing Experimental Base

CHINA INSTITUTE OF WATER RESOURCES AND HYDROPOWER RESEARCH

CONTENTS

Annual Report 2018

Vision and Strategy

Mission Achievement

中国水科院

CHINA INSTITUTE OF WATER RESOURCES AND HYDROPOWER RESEARCH

Management Achievement

Appendix

Annual Report

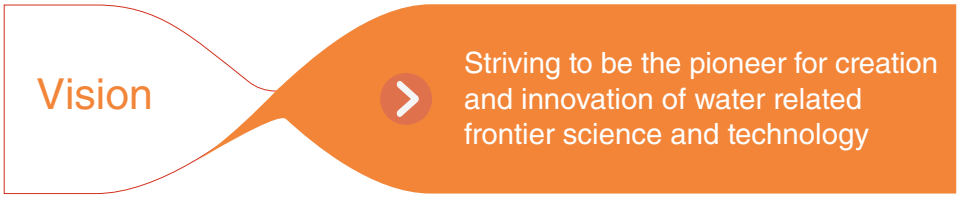
2018

CHINA INSTITUTE OF WATER RESOURCES AND HYDROPOWER RESEARCH

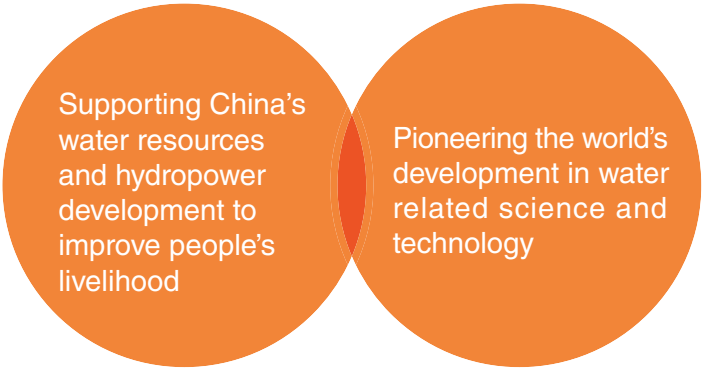
IWHR Headquarters (South)

Vision and Strategy

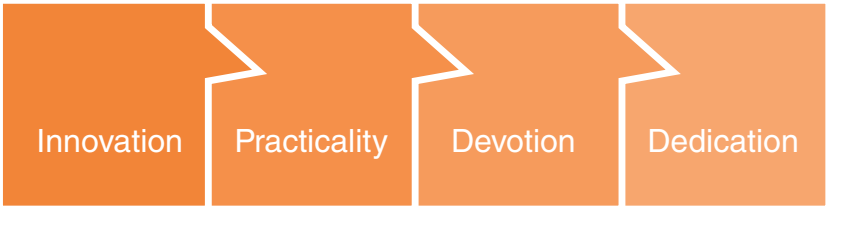
Vision



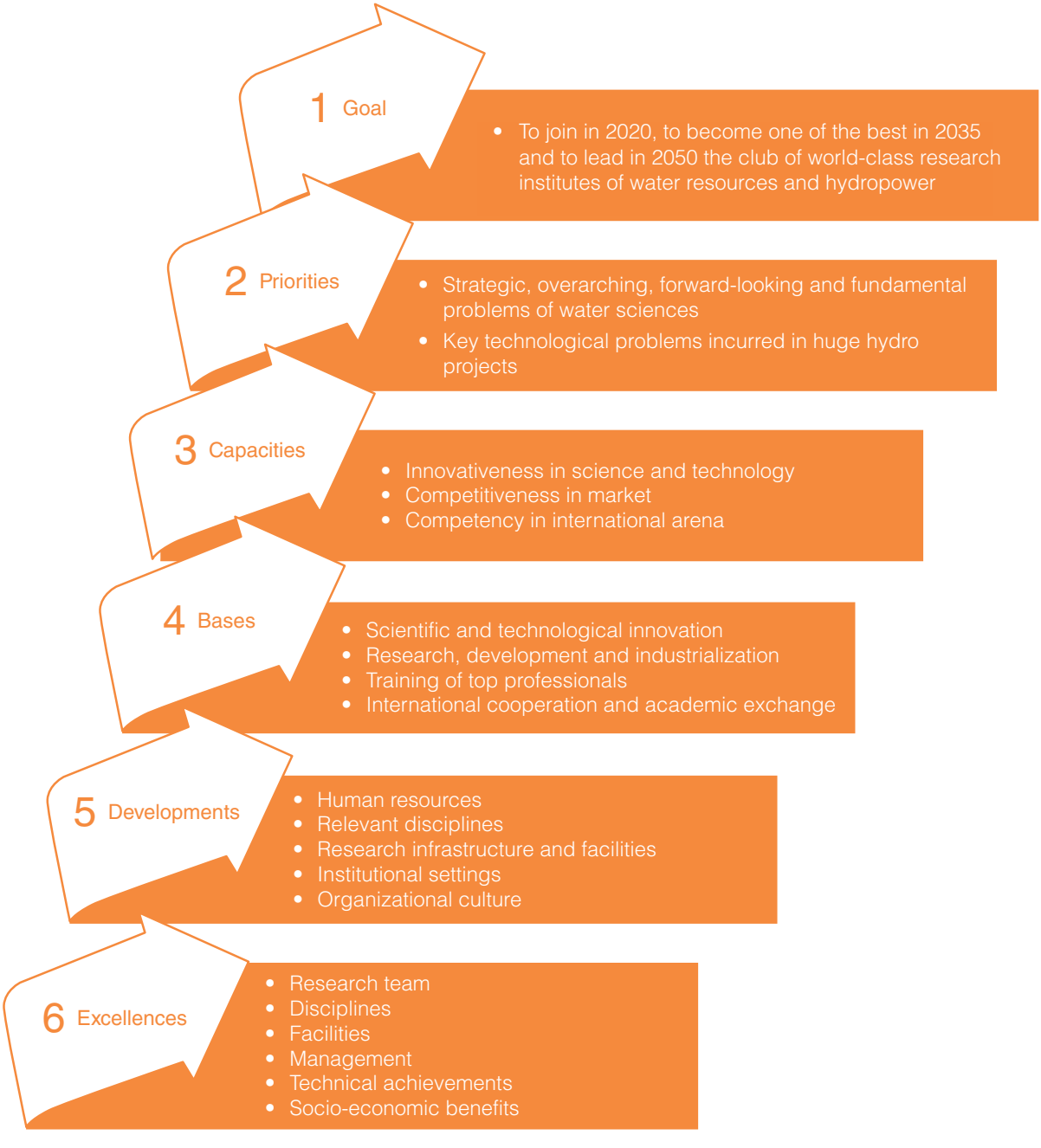
Mission



Spirit



Strategy


1 Goal
To join in 2020, to become one of the best in 2035 and to lead in 2050 the club of world-class research institutes of water resources and hydropower
2 Priorities
Strategic, overarching, forward-looking and fundamental problems of water sciences
Key technological problems incurred in huge hydro projects
3 Capacities
Innovativeness in science and technology
Competitiveness in market
Competency in international arena
4 Bases
Scientific and technological innovation
Research, development and industrialization
Training of top professionals
International cooperation and academic exchange
5 Developments
Human resources
Relevant disciplines
Research infrastructure and facilities
Institutional settings
Organizational culture
6 Excellences
Research team
Disciplines
Facilities
Management
Technical achievements
Socio-economic benefits

Annual Report

2011

CHINA INSTITUTE OF WATER RESOURCES AND HYDROPOWER RESEARCH

IWHR Headquarters (North)

Mission Achievement

IWHR Innovation

Research on the seismic safety of high concrete dams

A team led by Academician Chen Houqun

Keywords

High concrete dams, seismic input, dynamic mechanical properties of concrete material, seismic response analysis

Research Framework

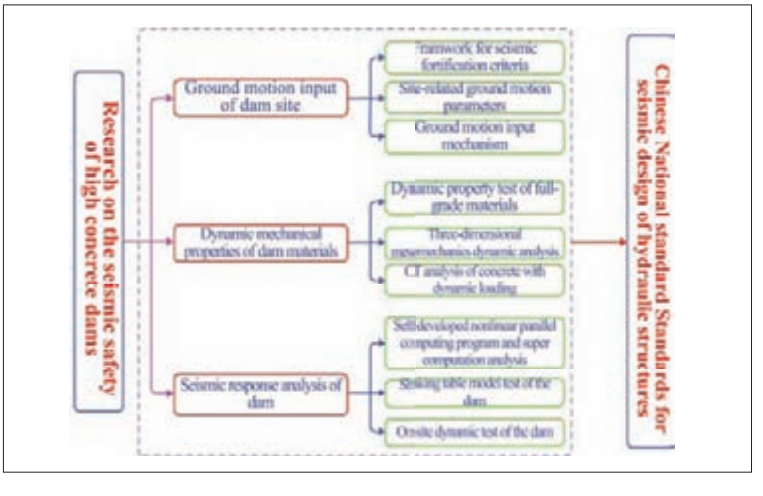
The framework of the research on seismic safety of high concrete dams mainly includes the seismic input at the dam site, the dynamic mechanical properties of dam concrete material and the seismic response analysis of dams, which are mutually complimentary.

1 Seismic input at the dam site

(1) The framework of seismic fortification criterion of hydraulic structures with respect to different functional objectives is established and gradually improved considering the national conditions of China and the characteristics and requirements of hydraulic structures; additional requirements are included for major high dams and reservoirs to check their seismic design which shall satisfy the performance objective of no "dam failure" under possible "maximum credible earthquake" at the dam site; the "stochastic finite fault method", a frontier subject in earthquake engineering at home and abroad, is adopted to directly generate the ground motion of maximum credible earthquake (MCE).

(2) Determination of site-related ground motion parameters

Replace the peak ground acceleration (PGA) with the effective peak acceleration (EPA) which is related to the response spectrum. A new approach is proposed to determine the site-related design response spectrum. According to the principle of maximum probability of incidence, select a "earthquake scenario" usually closest to the dam site along the main fault of a few key potential seismic source zones which may actually cause a design EPA at the dam site, then determine the site-related design response spectrum based on the selected attenuation relationship of response spectrum.



Framework of the research results on seismic safety of high concrete dam

In order to study the influence of frequency non-stationary ground motions on the nonlinear seismic response of various hydraulic concrete structures, the target spectrum of asymptotic power spectrum is fitted, and a new method for generating the artificially fitted stochastic seismic ground motion time history with non-stationary amplitude, frequency and phase by fitting the target progressive spectrum is proposed.

(3) Seismic input mechanism

In view of the importance of dynamic interaction between the dam and fonudation, the two parts are taken as a whole system to analyze its seismic response considering the mass foundation and radiation damping effect.

2 Dynamic mechanical properties of dam materials

(1) Dynamic property test of fully-graded concrete

In order to break the outmoded rule of only adopting wet-screened test specimens for dam concrete test, the compressive and flexural tensile strength and strain rate effects of full-graded specimens under cyclic variable amplitude loading are studied based on different practical projects. The constitutive relation of concrete in the whole process of tensile and compressive damages is successfully determined, which is very difficult and rare up to now and can provide a basis for nonlinear analysis of materials.

(2) Three-dimensional mesomechanics dynamic analysis

By taking the dam concrete as a composite material consisting of aggregates, cement slurry and their interface in accordance with the actual mix ratio, the mesomechanical dynamic analysis of the dam concrete considering the damage and strain-rate effects is performed. The results are mutually verificated with that of pre-static-loading and the associate mechanism is discussed.

(3) CT analysis of dynamic loading of concrete

Experiments are carried out with the "Dynamic Acoustic Emission" and X-ray CT equipement to study the process of internal cracking the concrete material, and the dynamic tension and compression loading equipment applicable to CT test are developed.

3 Seismic response analysis of dams

(1) Calculation and analysis of seismic response

a Breakthroughs in the theories and modeling for analysis

- The quasi-static method which is based on the plane assumption in structural mechanics is evolved to the finite-element-method-based dynamic method;
- The linear elastic problem which takes the dam as a whole structure is evolved to the 'dynamic contact theory' considering the contact nonlinear problems which contains the longitudinal/transverse joint opening, closing and sliding, and then to the material nonlinear problem based on damage mechanics considering the damage evolution of dam body and foundation rockmass;

- It is demonstrated that the reservoir water compressibility may be neglected and the hydrodynamic pressure on the dam surface may be taken as added mass, which could significantly simplify the simulation;
- A seismic analysis model of the whole dam-foundation-reservoirwater system consitent with engineering practice is estabished including some structure details (e.g. the dam joints), the complex geological conditions adjacent to the dam-foundation and their artificial boundaries, hydrodynamic pressure on the dam surface and other complicated factors.

b Improvement of analysis and calculation methods

- The seismic response analysis has been evolved from the vibration of a closed system which only reckons in the foundation elasticity within the frequency domain, to the fluctuation of an open system that considers the mass of the actual foundation and the dissipation of seismic wave energy to the far-field foundation within the time domain;
- A simple and new method considering the residual deformation is developed for calculating the system damage and damage process on the basis of the damage evolution test results.
- The seperated tensile and compressive strength checking and anti-sliding stability checking based on rigid limit equilibrium method is evolved into comprehensive analysis that couples the strength and stability, and the sudden change of displacement response is proposed as the quantitative criteria for identifying the engineering earthquake disaster.

c Application of high-performance analytic technique

The serial analysis based on small desktop computers is evolved to the high-performance parallel computation of exquisite system with massive freedom degree based on "cloud computing" technology and self-developed analysis software.

(2) Analysis for indoor shaking table model test

a The internationally advanced three-way six-freedom-degree large-scale hydraulic earthquake simulation hydraulic shaking table is built and the similarity criterion corresponding to small deformation is studied.

b The weighted rubber which meets the corresponding similarity requirements for water elasticity and the brittle model material which basically satisfies the tensil and compressive strength characteristics of concrete materials are developed.

c The testing technique which reflects the key potential sliding blocks, osmotic pressure, radiation damping and other effects of the transverse joints as well as the similar simulated dam foundation is developed.

(3) On-site prototype vibration test study

a The on-site prototype vibration test by means of microtremors, blasting, etc. is evolved to the on-site vibration test for different arch dams during the long-term scientific research collaboration between China and the US over the past 20 years;

Large-scale Testing Machine for Dynamic Performance of Full-grade Concrete

b It has progressed from the application of the four self-developed synchronous vibration machines to the adoption of the technology jointly developed by China and the US which combines the porous waterinfusion blasting downstream and underwater shallow rock-surface blasting upstream to generate the ground motion that could travel through the rock mass and energize the response of the dam-foundation-reservoir water system;

c The test has verified the analysis program for the natural vibration characteristics of the arch dam. Based on the analysis of the observation results, an important feature is discovered that the bottom reflection coefficient, which is very sensitive to the compressibility effect of the reservoir water, is significantly related to frequency and time and space, far from being the normally assumed fixed constant.

Research Application

1 Compilation and revision of standards for seismic design of hydraulic structures

IWHR, as the chief editor organization, has compiled and revised the Chinese standards and criteria for seismic design of hydraulic structures.

(1) The professional standard SDJ 10-78 Specifications for seismic design of hydraulic structures, which was issued in 1978 by the Ministry of Water Resources and Electric Power of the People's Republic of China;

(2) Finishing the DL 5973-1997 Specifications seismic design of hydraulic structures the Ministry of Power Industry of PRC and SL 203-97 Specifications for seismic design of hydraulic structures of the Ministry of Water Resources of PRC in 1997.

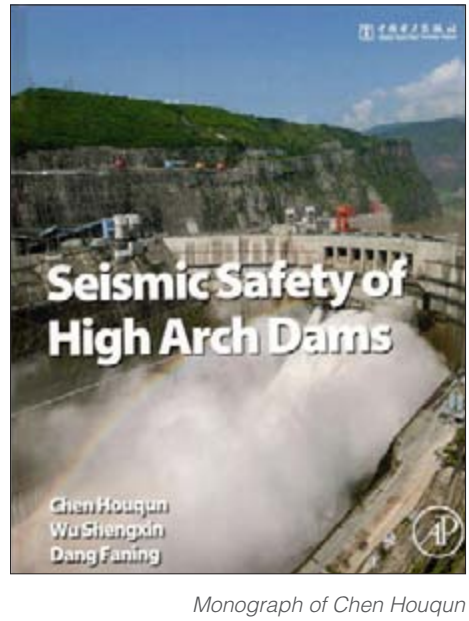
(3) NB 35047-2015 Code for seismic design of hydraulic structures of hydropower project", which is issued by the National Energy Administration under the National Development and Reform Commission of the People's Republic of China, and the Chinese national standard GB 51247-2018 Standards for seismic design of hydraulic structures.

2 Application in China's Water conservancy and hydropower projects

(1) The research achievements has been applied to the seismic design of all water conservancy and hydropower engineering projects in China, including Three Gorges Project, Xiluodu Hydropower Station, Xiaowan Hydropower Station, and Dagangshan Hydropower Station;

(2) The research achievements have also been applied in hydroprojects in other countries, such as Basha dam in Pakistan.

Shaking Table Test of Dam



Monograph of Chen Houqun

Representative Researches

Water Environmental Process and Effect of Pollutants in Reservoirs

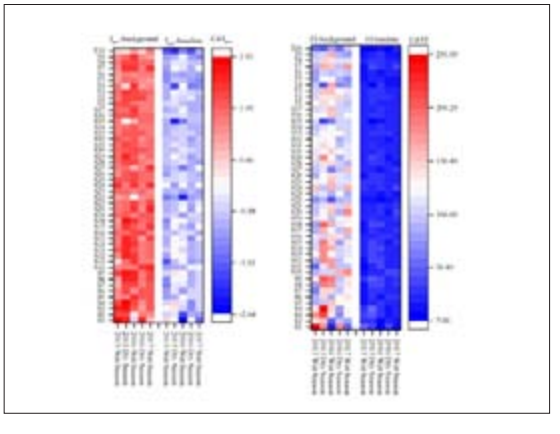
GAO Bo, PENG Wenqi, ZHOU Huaidong, et al.

Background

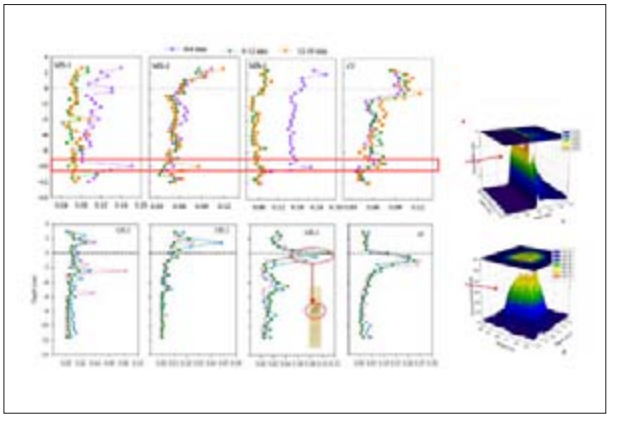
China has built over 98,000 reservoirs by 2017, which has the largest number of reservoirs in the world. Water environmental problems caused by reservoir construction and operation cannot be ignored. There have been numerous researches on rivers and lakes, but studies on reservoirs started quite late. As an important drinking water source, the impact of the migration and transformation of pollutants in reservoirs is an important issue for the safety of water quality of the reservoir. However, it is not clear whether the relevant research methods and evaluation technologies of traditional water environmental pollutants in lakes and rivers are fully applicable to reservoirs. Therefore, the research on water environmental process and effect of pollutants in reservoirs has both important theoretical and urgent practical significance.

Contents

- Scientific assessment of pollutants in reservoir sediments;
- Research on sediment-water interface process of labile metals in reservoirs;
- Release mechanism of pollutants in reservoir fluctuation zone;
- Source identification of heavy metal pollutants in Reservoirs;



Scientific assessment of pollutants in sediments in the Three Gorges reservoir



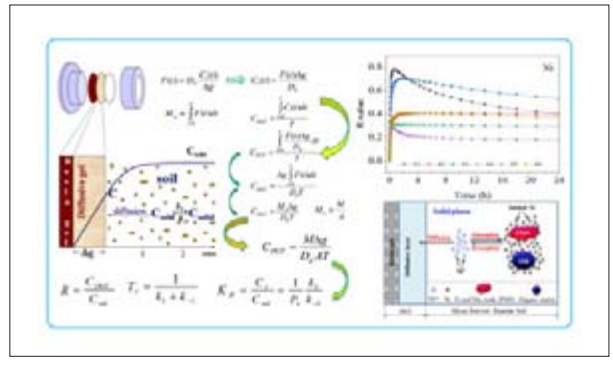
Sediment-water interface process of pollutants in reservoirs

Achievements

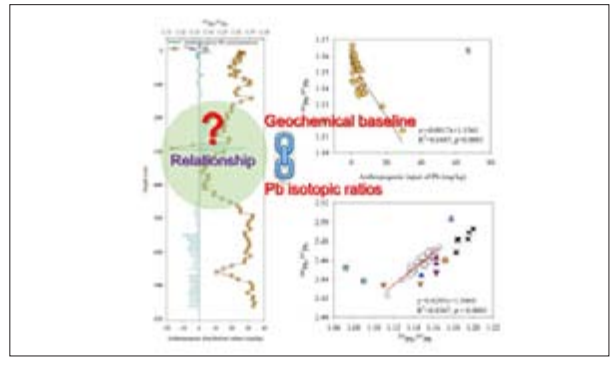
- An evaluation method based on sediment quality guideline and geochemical baseline is proposed and verified, which proves that the previous evaluation results overestimated the degree of heavy metals pollution in the Three Gorges Reservoir;
- The in-situ high-resolution diffusive gradient in thin-films (DGT) sampling analysis technology is adopted to reveal the release mechanism of labile metals at the water-sediment interface, and the release flux of labile metals at the sediment-water interface of the Three Gorges Reservoir is quantitatively calculated;
- Release release dynamics process and mechanism of heavy metal pollutants in the riparian soils were predicted in the Miyun Reservoir of Beijing. A method for quantitatively calculating the storage capacity of lable metals in the fluctuating zone is proposed;
- The source apportionment methods combining “geochemical baseline” and “stable isotope tracer” are established. The anthropogenic contribution rate of heavy metal pollutants in the sediments of the Three Gorges Reservoir is quantitatively calculated. The total stock amount, anthropogenic imput stock amount and easily mobile stock amount of heavy metals in the sediments of the Three Gorges Reservoir are estimated for the first time.

Application

- The evolution mechanism of water environment of heavy metals is systematically revealed in the Three Gorges Reservoir; An evaluation method based on sediment quality guideline and geochemical baseline is proposed and verified. The evaluation framework system of heavy metal pollution in the Three Gorges Reservoir is established;
- The results are adopted to predict the release risk and dynamics process of heavy metal pollutants in the riparian soils of Miyun Reservoir, and provide a new theoretical basis for scientific prediction of environmental geochemical behavior and release risk of regional pollutants caused by large-scale water transfer projects.



Release mechanism of pollutants in reservoir fluctuation zone



Source identification of heavy metal pollutants in Reservoirs

IWHR

Research and Application of Urban Flood Simulation Technology

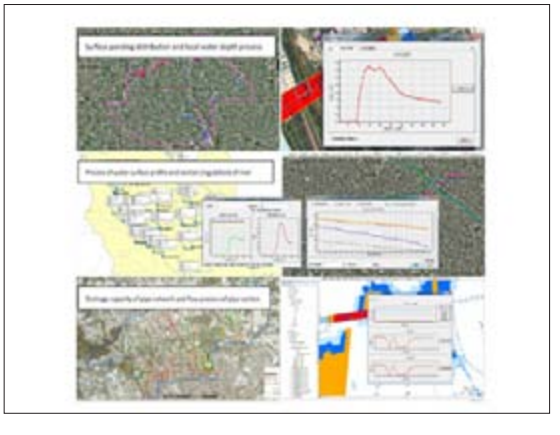
HU Changwei, ZHENG Jingwei, SUN Yang, et al.

Background

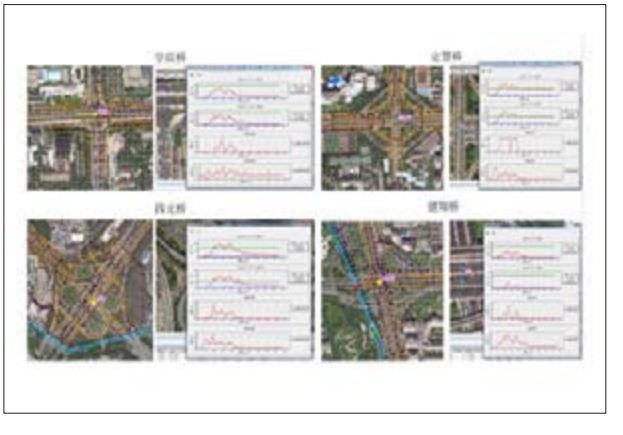
Urban flood simulation is the basic and core research on the disaster mechanism, preventive measures, post-disaster relief and engineering planning and design of urban flood disasters. Foreign commercial software used in urban flood simulation research has such problems as limited accessibility to core structure, difficult expansion of model functions, and difficult application in integrated development of system, bringing formidable troubles to flood control emergency application. However, the independently developed models are mostly at the research stage. There are no mature cases for large-scale urban flood simulation due to low computational efficiency and insufficient engineering treatment methods. In this research, Beijing is taken as a pilot city for waterlogging early warning. A fine waterlogging model for downtown Beijing is established by area. Suggestions are put forward to handle waterlogging in Beijing and the pilot project of waterlogging early warning is gradually constructed.

Contents

- A multi-dimensional coupling urban flood simulation model is established to simulate and calculate the rainfall runoff, river confluence, pipe network confluence and other water flow processes under the operation of flood control and drainage projects such as reservoirs and gates in the region and to carry out real-time coupling calculation;
- Total-factor massive data processing technology for cities, including collection and processing of basic data, and investigation, supplementary survey and check of river section and drainage pipe network, and drainage outlet survey, etc.;
- According to typical rainfall observation data provided by Beijing Hydrological Station, the temporal and spatial distribution characteristics of typical rainfall in downtown Beijing are analyzed, and a typical rainfall scenario database is established;
- System design and development, early warning of waterlogging and analysis of waterlogging in urban areas are carried out.



Schematic diagram of calculation results of urban flood simulation model of Beijing



Schematic diagram of interchange waterlogging ledger of Beijing

Achievements

- A one-dimensional river model, a two-dimensional surface sub-region model, an underground pipe network model and its flood analysis model for coupling computation are built to simulate the entire process of urban rain and flood movement;
- The overall model for Beijing is adopted to simulate 504 typical rainfall scenarios based on the analysis results of rainfall distribution characteristics in downtown Beijing, and a database of typical rainfall scenarios is established to provide a basis for construction of the waterlogging early warning pilot project;
- According to the actual data conditions, including the pipe network data conditions are met and poor data conditions or non-urbanized areas, various coupling generalizations are provided;
- The system for the construction of waterlogging early warning pilot project and the urban river and lake control is developed. Urban river and lake control of the flood control system for key river basins in Beijing is modified to calculate the control and operation process of all gates and dams in urban rivers and lakes in real time.

Application

A set of urban flood simulation technology system developed and constructed has been tried out in the flood seasons of the past two years. Each rainstorm is simulated according to the weather forecast based scenario, and the results are submitted to the Beijing Flood Control and Drought Relief Office for decision-making, achieving remarkable social and economic benefits. A flood simulation research and application project for Hewan District of Shenzhen in south China's Guangdong Province is putting into practice.

Practical application of urban flood simulation model of Beijing

Various generalization tools for handling local micro-topography and pipe networks

Research on Key Technology of Fine Simulation and Dynamic Control of Face Rockfill Dam

WEI Yingqi, LI Yongjiang, CAI Zhengyin, et al.

Background

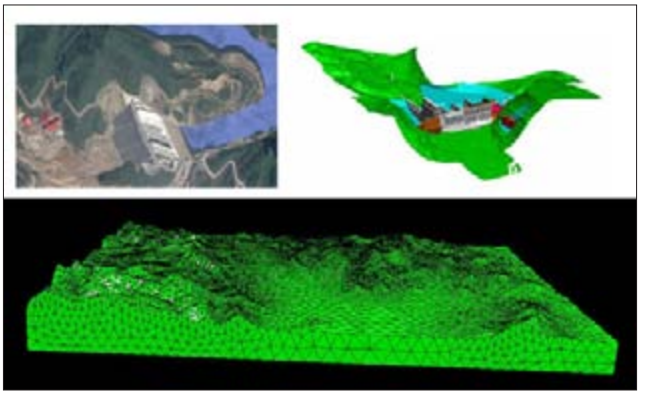
As concrete face rockfill dam gets higher and the dam foundation conditions become more complicated, the safety control requirements are getting increasingly stringent. Considering the influence of seepage field and temperature field, establishing models of scale effect, time effect, dilatancy, wetting and seepage and other properties of rockfill materials can significantly improve its stress and deformation analysis level. The establishment of water-heat-force coupling mathematical model, the study of structural simulation, material model, acceleration algorithm and so forth in the fine simulation and dynamic control of face rockfill dam, and the study on the prediction method of stress and deformation characteristics in the entire service life of dam are of great significance to improve the deformation control level of face rockfill dam and ensure the successful construction and safe operation of the dam.

Contents

- Research on theoretical construction and numerical analysis method of CFRD based on three-field coupling;
- Integrated construction technology of 3D digital dam model;
- Research on mechanical properties and constitutive model of rockfill materials;
- Research on GPU parallel acceleration algorithm for large-scale fine simulation of face rockfill dam;
- Research on safety monitoring and data analysis methods;
- Research on dynamic control and analysis method of face rockfill dam;
- Establishment of platform for fine simulation and dynamic analysis of concrete face rockfill dam.

Achievements

- The theoretical framework of unity coupling of seepage field, temperature field and stress field is established, the numerical simulation analysis method of face rockfill dam based on three-field coupling is proposed, and the numerical simulation analysis software of high fill based on three-field coupling is developed;
- The 3D intelligent modeling technology for geology, surface and dam body is proposed, and a 3D integrated digital dam model based on vector pyramid technology is established for two core purposes of numerical analysis and 3D virtual simulation;

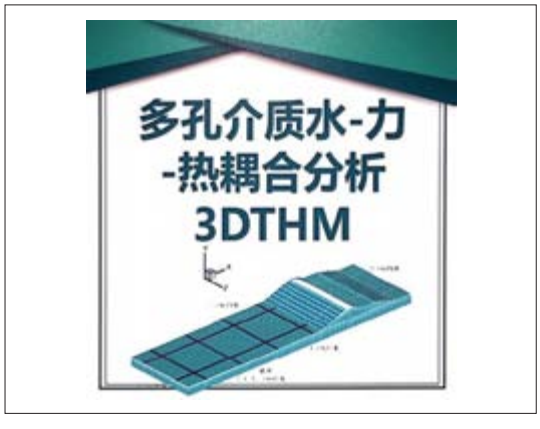


Convert 3D integrated BIM model into refined mesh

- A logarithmic model of E-B model parameter K and the maximum particle size, a rheological power function model, an eight-parameter wetting model and a dilatancy equation with multiple internal state variables applicable to rockfill materials are proposed, the scaling criteria and methods for permeability tests of coarse-grained materials are improved, and the design criteria for cushion materials and transitional materials of face rockfill dam are proposed;
- The GPU parallel acceleration algorithm with fine simulation is developed, and the optimization algorithm of grid and numerical iterative solution is proposed, significantly improving the solving speed of fine simulation of face rockfill dam;
- A theoretical method for uncertainty analysis of monitoring data and a fine simulation method for dynamic analysis of face rockfill dam are proposed and the intelligent analysis of deformation and seepage of face rockfill dam is carried out;
- A new distributed optical fiber monitoring method for layered settlement of the dam is designed and developed. The Bayesian back analysis model for uncertainties of monitoring data is proposed, and a comprehensive theoretical method of back analysis based on data reliability and importance weights is proposed;
- The Dam Information Management Platform V1.0 for face rockfill dam reservoir is developed. The platform is equipped with several professional analysis subsystems, including numerical analysis subsystem, monitoring subsystem and forecast and early warning subsystem and so forth.

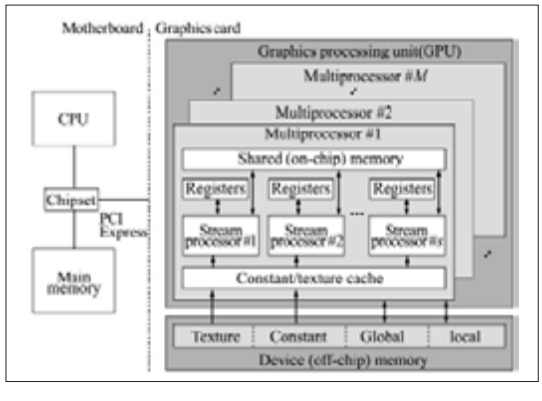
Application

Research results of the project have been successfully applied to the construction control of Hekou Village Reservoir, Jilin Taiyiji Hydropower Station, Shanshandian Reservoir, Qianping Reservoir and other projects, ensuring the normal construction of the projects and bringing great social, economic and ecological benefits, with a total profit of RMB 951 million over the years.

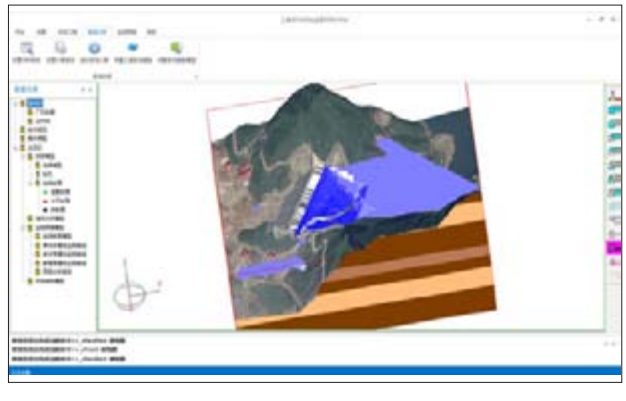


Three-field coupled simulation analysis software

Independently designed and developed SR-4 mile-controlled high-pressure triaxial rheometer



GPU-based accelerated computing framework



3D digital dam information management system

Key Technology and Practice of New Polyurea Anti-seepage System for Middle Route of South-to-North Water Transfer Project

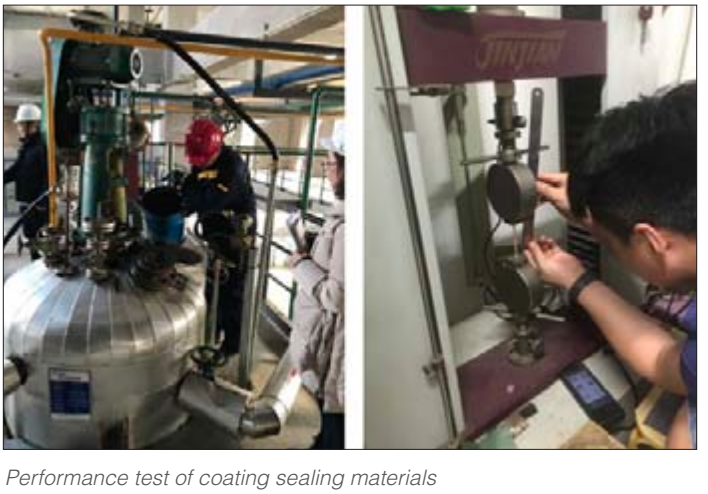
LI Bingqi, ZHANG Guoxin, LIU Yi, et al.

Background

Middle Route of the South-to-North Water Transfer Project is the major strategic infrastructure built for alleviating the shortage of water resources in northern China, optimizing allocation of water resources and improving the ecological environment. In terms of reducing the loss of water resources caused by leakage and ensuring the safe operation of hydraulic structures in the water transfer process, there are numerous technical problems related to seepage control, such as the design and material performance indicators of seepage control structures, the performance of high-performance seepage control materials, the evaluation of material quality, and the process control during construction. This research is systematically carried out in terms of theoretical model, materials, testing methods, equipment, construction technology and other aspects, developing a set of key technologies of polyurea-based anti-seepage system which aims to fill a design void of anti-seepage structure and material performance indicators and break through the barriers causing limited application of anti-seepage materials in complex environments. It is of great practical significance.

Contents

- Theoretical research on the design of anti-seepage structure and material performance indicators;
- Research on polyurea-based anti-seepage system materials suitable for hydraulic structures in the Middle Route of the South-to-North Water Transfer Project;
- Establishment of quality evaluation and service life prediction of polyurea anti-seepage system materials;
- The expansion and application of polyurea-based anti-seepage system, and the research on rapid detection method of sealing effect;
- Improvement and perfection of polyurea-based anti-seepage system construction method (EP_DTEW), and practical engineering application and promotion of key technologies of polyurea-based anti-seepage system.



Performance test of coating sealing materials

Achievements

- A stripping model of multi-interface anti-seepage system is established;
- High-performance polyurea-based composite anti-seepage system materials are developed;
- Quality evaluation and system service life prediction methods of polyurea based materials are proposed;
- Rapid detection method of sealing effect of sealing structures is invented;
- Polyurea-based composite anti-seepage system construction method is developed.

Application

The achievements have been successfully applied to the detection and evaluation of the sealing effect of the Yellow River Crossing Tunnel and Tianjin Box Culvert in the Middle Route of the South-to-North Water Transfer Project before operation, meeting the domestic water needs the Beijing-Tianjin-Hebei region, creating tremendous social benefits. The achievements have also been successfully applied in the 360m high berm project of Xiluodu Hydropower Station, the abrasion and erosion prevention project of the flood discharge tunnel of Daotang Reservoir in Guizhou, the emergency rescue project of Wuyin Channel, the large-deformation flexible seepage prevention project of stone masonry dam face of Yongding Bridge on Dadu River, and the freeze-thaw repair test project of Yanghe Channel in Zhangjiakou, achieving good results. Direct economic benefits arising from the application in the above projects are RMB 781 million in total.

Application in Tianjin Box Culvert of the Middle Route of South-to-North Water Transfer Project

Application in the Yellow River crossing tunnel in the Middle Route of South-to-North Water Transfer Project

Study on the Seismic Test and Analysis for Storage Rack of Spent Fuel of Nuclear Power Plant

HU Xiao, ZHANG Yanhong, QIAN Hao, et al.

Background

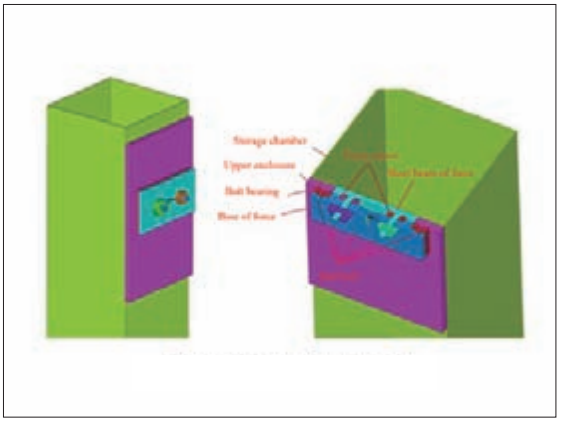
The safe and reliable operation of storage rack of spent fuel has an important impact on continuous, stable and safe operation of nuclear power plants. Earthquake resistance is one of the requirements that the storage rack of new/spent fuel must meet. The seismic analysis of storage rack of spent fuel involves geometric nonlinearity under fluid-solid coupling conditions, such as slippage and collision between the spent fuel assembly and the storage cavity of storage rack, and between storage racks, making it extremely difficult and complicated to solve the problem. These nonlinear and fluid-solid coupling effects are difficult to predict both at home and abroad. In this study, seismic tests were carried out on the test piece of CAP1400 storage rack of spent fuel, and the seismic analysis pattern and method of storage rack were verified and revised, so as to develop a complete set of seismic test and non-linear analysis technologies for the storage rack of spent fuel with independent intellectual property rights, providing technical support for guidance on the design and optimization of storage rack equipment.

Contents

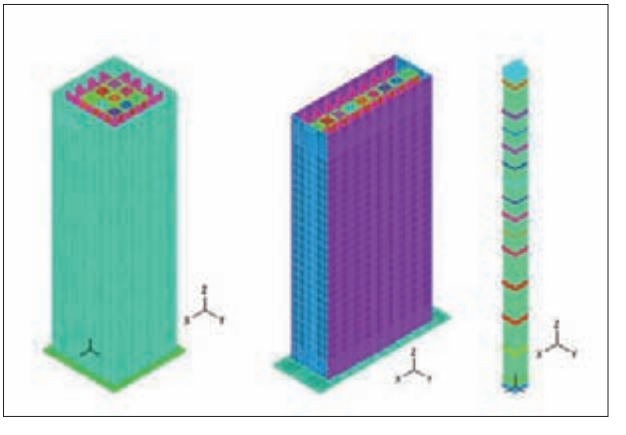
- Seismic test of storage rack of spent fuel;
- Nonlinear seismic response analysis of 3×3 and 1×9 seismic test pieces of the storage rack of spent fuel;
- Analysis, comparison and summary of the seismic test results under various working conditions.

Achievements

- Through independent research and development, we have mastered a complete set of non-linear seismic analysis technologies for the entire spent fuel pool of the free-structure storage rack of spent fuel, which has been verified by the full-scale model test;
- Non-linear effects such as collision, slippage, toppling (vibration), torsion and fluid-solid coupling are considered in the seismic analysis of the free-structure storage rack of spent fuel;



Collision force measurement facility



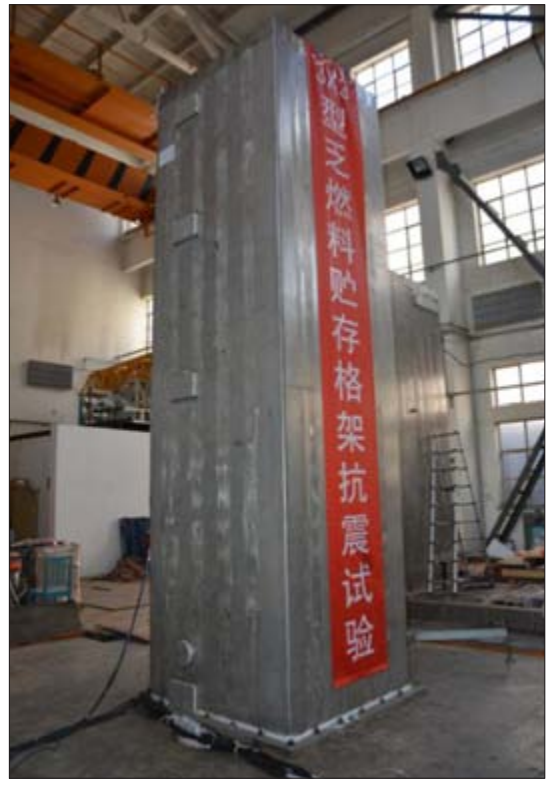
FE models for 3×3 and 1×9 storage racks and fuel assemblies

- The hydrodynamic mass matrix is obtained by deriving the hydrodynamic mass formula independently, and the local stiffness of the structure is acquired by analyzing the dynamic characteristics of the structure and 3D modeling calculations of the storage rack, so that the model is more accurate and realistic;
- The time history generation path and method meeting the power spectral density (PSD) or equivalent requirements are studied and obtained, complying with the requirements of HAF-J0053 Guidance on Seismic Qualification Tests of Nuclear Equipment. It sets an international precedent;
- The seismic test method of the storage rack of spent fuel is mastered, and the seismic response effects at different horizontal directions and with various quantities of fuel assemblies under conditions with/without water are tested and studied, and relevant parameters are obtained, which is the first of its kind in China.

Application

- The research results have been applied to the design of CAP1400 storage rack of spent fuel of nuclear power plant, and could also be applied to the storage racks of spent fuel with free structures in other 2nd and 3rd generation PWR reactors;
- It has been successfully applied to the engineering problems of the storage rack of spent fuel of Sanmen Nuclear Power Station, and solved the practical problems facing the storage rack of spent fuel of the nuclear power plant of Sanmen Project;
- With indigenous production, the purchase price of the storage rack of spent fuel has been lowered by about 6-12 million RMB, effectively reducing the purchase cost of equipment.

Test piece of 1×9 storage rack of spent fuel



Test piece of 3×3 storage rack of spent fuel

IWHR

Research and Application of Key Technologies of Intelligent Construction and Management of Water Conservancy Projects

WANG Yujie, ZHAO Yufei, WEN Yanfeng, et al.

Background

At present, with the continuous development of information technology, more and more information technologies have been applied in water conservancy construction, improving the water conservancy construction management level. However, with the development of big data, cloud platform and IoT technology, the intelligent management requirements of water conservancy construction are getting increasingly stringent, which is mainly reflected by (1) the application of various management systems based on information technology in water conservancy construction management is relatively isolated at present, and no practical cooperative management platform for different units has been established; (2) the lack of unified collection standards for important construction information in engineering construction has led to information isolation; (3) the key construction process management and control in water conservancy construction are not intelligent enough. Therefore, improving the intelligent management level in water conservancy construction with information technology is urgent.

Contents

- Research on the construction and application of the cloud platform for water conservancy construction and management, and on the collection, transmission, analysis and display standards of all kinds of important information during water conservancy construction in combination with the construction of the platform;
- Research on key technologies of water conservancy construction information management system based on standardization and digitalization;
- Development of intelligent dam filling and rolling system to effectively improve the construction quality and progress;
- Research and development of intelligent grouting management and analysis system based on whole-process information collection and mining.

Overall architecture diagram of cloud management platform for water conservancy construction

Document management of water conservancy construction

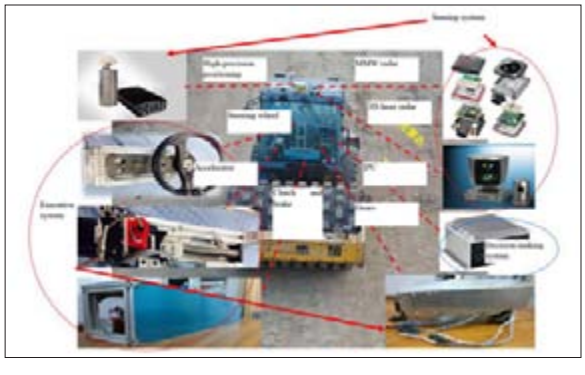
Achievements

- Based on cloud computing, IoT and data mining, a cloud platform for real-time data collection, transmission and sharing of water conservancy construction management has been established;
- A digital, unique and cloud-based standard system for the whole process of water conservancy construction information management is proposed, which realizes fine management of water conservancy construction process and establishes a digital document center for water conservancy construction;
- The intelligent filling system of roller-compacted dam based on IoT and big data technologies is developed, including the real-time, intelligent, whole-process dam filling construction monitoring system and the unmanned operation system of compacting machinery;
- Combined with DIPTM, borehole acoustic wave, borehole TV and cross-hole CT technology, an intelligent grouting management and analysis system based on whole-process information collection and mining is developed.

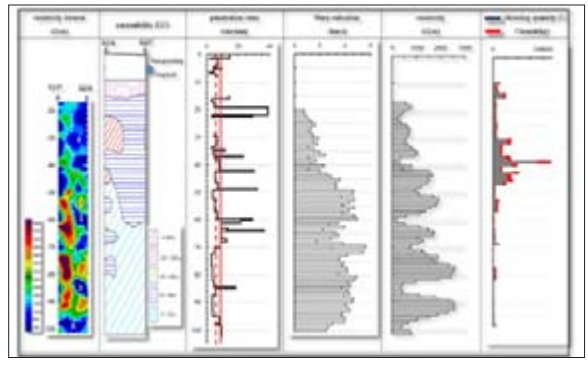
Application

The research results of the project have been applied in Chushandian Reservoir in Henan Province, Altash Water Control Project in Xinjiang Uygur Autonomous Region, Jiangxiang Reservoir in Anhui Province, Nam Ngum 3 Hydropower Plant in Laos, Dehou Reservoir in Yunnan Province and other projects. Good application results have been achieved and significant social and economic benefits have been produced.

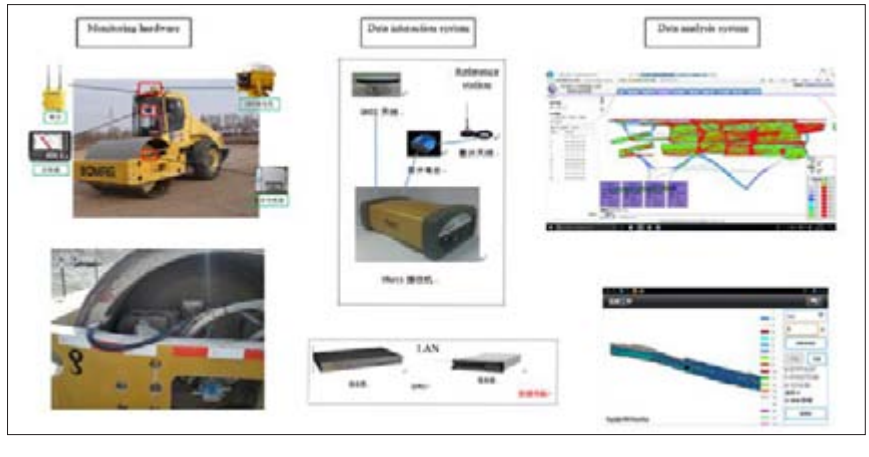
The promotion and application of the research results in engineering practices will greatly improve the water conservancy construction quality, ensure reliable operation of water conservancy projects, realize normal and sustainable development of the benefits of the water conservancy projects, and produce significant social benefits.



Intelligent dam filling and rolling system based on unmanned operation technology of filling machinery



Schematic diagram of comparative analysis for whole-process information of grouting works



Real-time and intelligent monitoring system for dam filling construction process

IWHR

The Development and Application of Multi-Metal Oxide Complex Adsorbents for Fluoride Removal in Rural Water Supply

WU Xiaomei, JIA Yannan, Song Weikun, et al.

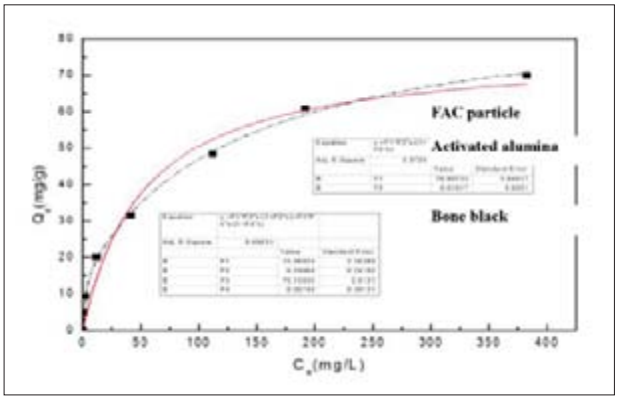
Background

High-fluoride water can be widely found in China. Drinking high-fluoride water for a long time will lead to fluorosis diseases such as dental fluorosis and skeletal fluorosis, hence making it one of the key problems to be solved in rural water supply. At present, the commonly used adsorption fluoride removal technology has such problems as low adsorption capacity, poor adaptability to water quality, and frequent regeneration and so forth. Fluoride removal in rural water supply has not been fundamentally solved. It is urgent to develop fluoride removal technology and equipment with high capacity of fluoride, low operation cost and convenient management. The Fe-Al-Ce tri-metal composite powder adsorbents has shown excellent fluoride removal performance in previous studies, and research and development on related materials and equipment have been conducted.

Contents

- Research and development of compound-metal oxide composite adsorption materials for fluoride removal;
- Research and development and finalization of large-scale and household fluoride removal equipment;
- Research on the technical mode of fluoride removal treatment for rural water supply.

Particulate Fe-Al-C e(left) and Mg-Fe-Ce (right) fluoride removal adsorbents



Fluoride adsorption isotherms of particulate Mg-Fe-Ce (pH=7.0)

Achievements

- Particle Fe-Al-Ce (GFAC) and Mg-Fe-Ce (GMFC) composite metal oxide adsorption materials for fluoride removal have been developed, with excellent adsorption capacity over 3 times larger than that of traditional adsorbents;
- For the first time, the adsorption fluoride removal equipment for household terminals introduces the environmental protection concept of quality-based water supply and integrates technical units such as membrane filtration, activated carbon adsorption and ultraviolet disinfection to further improve the water quality and taste;
- Three fluoride removal technical modes suitable for different water source quality and water supply scales are systematically put forward, which provide technical schemes for high-fluoride water treatment in different regions.

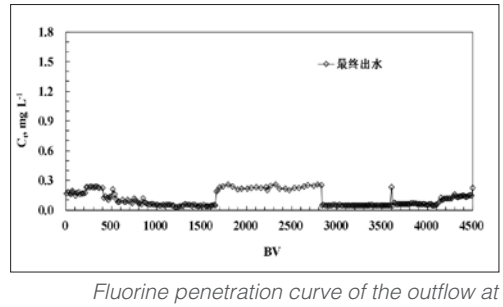
Application

It has been applied in 58 projects in 4 provinces and municipalities such as Beijing, Hebei, Shandong and Anhui, covering a population of more than 27,400. Training Materials for High-Fluoride Water Treatment Technology for Rural Water Supply and Brochure for Promotion and Application of High-Fluoride Water Treatment Technology for Rural Water Supply have been compiled, which have been distributed at the national, provincial and county level technical exchange and training seminars. The high-fluoride water treatment technology is promoted to the grassroots units, reducing the treatment costs caused by fluoride and ensuring the drinking water safety of rural residents in the project area.

A comparison of capacity between GFAC, GMFC and counterpart products

Fluoride removal adsorbents	Max. absorbing capacity（pH）	penetration adsorption capacity on site
Activated alumina	11.3 mg/g（7.0）	0.8-1.2mg/g
Activated zeolite	28.6 mg/g（6.0）	~1.0 mg/g
Bone charcoal	7.48 mg/g（7.0）	~1.0 mg/g
hydroxyapatite	15.8 mg/g（7.0）	~1.0 mg/g
READ- F®	11.1 mg/g （7.0）	>4.0 mg/g（pH < 4）
GFAC	51 mg/g（7.0）	4.0 mg/g
GMFC	90 mg/g（7.0）	>6.8 mg/g

Adsorption fluoride removal equipment for household terminals



Fluorine penetration curve of the outflow at Pinggu demonstration project

Technical seminar for high-fluoride water treatment for rural water supply in north China (Langfang, ShiJiaZhuang)

IWHR

Key Technologies for Water Supply in Arid Pastures in North China

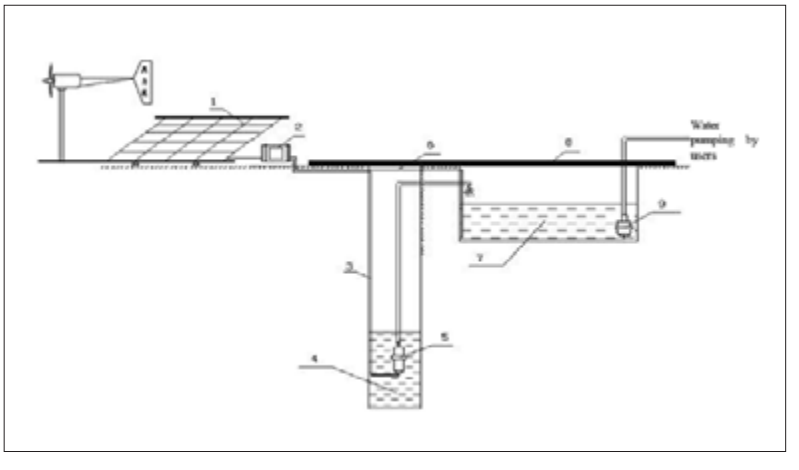
WU Yongzhong, WANG Shifeng, LI Liang, et al.

Background

The pasture animal husbandry is the basis of economic development in pastoral areas and the main source of income for herdsmen. Pastures water supply is one of the decisive factors for the development of animal husbandry. There are some problems in pastures in North China, such as backward development of drinking water projects, lack of conventional power for water pumping, inefficiency of existing new energy water supply equipment and unreliable operation.. The water supply technology of pasture is obviously backward, which seriously affects the healthy and sustainable development of animal husbandry. As there is no relevant technical system and water supply strategy for water supply in pastures, the water supply methods in pastoral areas indiscriminately imitate those in agricultural areas. However, the natural and environmental conditions in pastoral areas are quite different from those in agricultural areas, so the methods and techniques of water supply in agricultural areas are not applicable in pastoral areas. Therefore, it is very necessary to carry out the research on the key technology of water supply in pastures for the cultivating the subject of pastoral water supply and solving the development problem of pastoral water conservancy science and technology .

Contents

- Research on water supply indicator system for different types of pastures;
- Research on the technical scheme and engineering mode of water supply according to the natural conditions of pastures in North China;
- Research on key technologies and equipment of water supply for pastures;
- Demonstration research on water supply in pastures of Inner Mongolia, Qinghai and Xinjiang.



Water supply mode for pastures with wind-solar hybrid power system

Achievements

- The optimal layout of water supply points for different types of pastures in North China has been established;
- The advanced water pumping equipment (including new energy water pumping), durable water delivery, distribution technology and automatic water supply terminals are reasonably integrated to form a practical, reliable and economical advanced water supply system for pastures;
- According to the characteristics of different regions, six standardized water supply modes for pastures have been established, and six sets of new water supply equipment that can be popularized have been developed, of which two have been rated as high-tech products;
- A series of water supply index systems for different types of pastures were established, which filled the gap of water supply index in pastoral areas of China.

Application

The research results have been demonstrated and promoted in representative arid pastures in eastern and western Inner Mongolia, Xinjiang and Qinghai. Seven demonstration sites have been built, which could supply drinking water to 95 herdsmen and 10,000 livestock, achieving remarkable effects. Meanwhile, the results have been promoted to more than 30 sites, with a total installed capacity of 60 kW of new energy in water supply points, protecting 900 km^2 of natural pasture. The results of the project have significant application value.

Special new energy driven water pump with certification of stereotyped products

Experimental production base of wind energy and solar energy water supply equipment for pastures

Water supply for the pasture with wind-solar hybrid power system in Inner Mongolia

Best Papers

in Journal of IWHR

Investigation into the conceptual model for evaluating the environmental and ecological impacts of River and Lake System Interconnection

FENG Shunxin, LIAO Wengen, WANG Junna

Abstract: River and Lake System Interconnection (RLSI) is an important strategy employed presently for water resources management. It is also a key measure for improving the capacity of water resources allocation,enhancing flood and drought control and improving eco-environment. The evaluation of the environmental and ecological impacts of RLSI can provide a good basis for the decision-making concerning RLSI. In this paper, several aspects of the impact evaluation of RLSI different from those of other types of water projects were discussed. It was pointed out that the specific space structure of the connected region may result in multiple threshold values of an environmental or ecological impact evaluation index. A conceptual model was proposed for the evaluatlon of the environmental and ecological impacts of RLSI in the whole connected region, as well as the evaluation method based on this model. The limitations of the conceptual model and the perspectives in the impact evaluation of RLSI were discussed finally.

Key words: River and Lake System Interconnection (RLSI); impact; evaluation; conceptual model

Test study on the tensile stress-deformation curve of fully-graded concrete

ZHANG Yanhong, HU Xiao, YANG Chen

Abstract: Tensile stress-deformation curve of fully-graded concrete is very important for the nonlinear response calculation and the critical seismic capability analysis of dams. In this paper, the advanced closed-loop servo testing machine is used to perform the axial tension test on Φ450 mm×1300 mm cylindrical specimens (max aggregate size of 150 mm) under the control of displacement mode, from which the complete curves of tensile stress versus tensile deformation in given range are obtained. After the maximum load,cyclic loads under different stress levels are applied to study the unloading and reloading curves. Simple equations are suggested to fit the complete stress-deformation curves and the unloading/reloading curves of the fully-graded concrete. This paper provides a reference basis for the dam concrete model building in numerical analysis.

Key words: Hydraulic structure engineering; fully-graded concrete; axial tension test; stress-deformation curve; strain rate

Centrifuge modeling of municipal solid waste slope failure

HOU Yujing, PENG Ren, ZHANG Xuedong, WANG Cun, LIANG Jianhui, JIA Chenghong

Abstract: Large portion of municipal solid waste has to be stored in valleys or landfill around cities in China. There is potential risk of slope failure for those solid wastes under rain storm causing high leachate level inside the landfill,sometimes leading to flow slide. Tremendous loss of life and property had been re-ported in the past. This paper presents the centrifuge model tests to simulate the slope failure phenomenon of the municipal solid waste, based on the simulated waste material with higher water content. In order to observe the slope failure for each model test, a rotating container was developed to increase the model slope angle during centrifuge spinning. Solid waste models were tested to failure respectively under different layout with medium and old age of waste storage, with analysis results based on the model slope monitor-ing data and image analyzing method. A useful method is presented in this paper to evaluate the safety po-tential of the initial model slope based on the slope failure information from centrifuge model tests.

Key words: Centrifuge modeling; rotating container; solid waste; slope failure; leachate

Land use change and its ecological environmental effect in the upstream of Yongding River

HOU Lei, PENG Wenqi, LIU Peibin, CHEN Quchang, QU Xiaodong, DONG Fei

Abstract: Based on the four spatial data sets of land use and land cover change of 1980, 1990, 2000 and 2010 in the upstream of the Yongding River, we quantitatively calculated the land use dynamic degree, the transfer matrix between the land use types and ecological environmental quality index, and analyzed the land use change and its ecological environment effect in the upstream of the Yongding River. The result shows that (1) During the past 30 years, the proportion of land use/cover in the study area was ranked as:farm land > grassland > forest land > urban and built up land > water > unutilized land. The comprehensive dynamic degree of land use during 1980-1990 and 1990-2000 was 0.06% and 0.19%, respectively, and the land-use change rates and transfer rates were not more than 10% and the land use/cover change was small between the two period; while the comprehensive dynamic degree of land use was 6% and the land-use change rates and transfer rates were greater than 10% during the period from 2000 to 2010, and the land use/cover changed greatly. (2) During 2000-2010, the regional eco-environment quality index increased from 0.4230 to 0.4290, and the regional eco-environment quality improved slightly; while the overall quality of regional eco-environment remained relatively stable,and the soil and water loss control measures and the expansion of construction land of the area had a profound impact on the regional eco-environment. The study provided the technical support for the land use structure optimization and the improvement of the ecological environment in the upstream of the Yongding River.

Key words: The upstream of Yongding River; land use change; the ecological environment effect

IWHR

in Journal of Hydraulic Engineering

Breaking ice with explosive in Heilongjiang River

LIU Zhiping, WANG Tao, GUO Xinlei, FU Hui, YANG Kailin, PENG Xuming

Abstract: Breaking ice cover or ice jam is essential to prevent flooding in Alpine region. Field experiments have been conducted to study ice-breaking process with explosive in the upper reach of the Heilongjiang River (Amur River) for several years. It is observed that the water depth under the ice cover is a crucial factor affecting crater radius of the breaking ice cover after explosion. Based on the experimental results, a theoretical model is developed to correlate the crater radius and the water depth, the cover thickness, and the explosive charge weight. The application of the model in the Heilongjiang River in 2015-2016 showed good agreement between predicted and measured crater radius. This research provides the scientific basis for breaking ice with explosive to prevent ice disaster in the river of Alpine region.

Key words: Heilongjiang (Amur) River; river ice; ice cover; thickness; flood; blast; explosive

Systematic construction pattern of the sponge city

WANG Hao, MEI Chao, LIU Jiahong

Abstract: Sponge city is a new strategy of integrated urban water management in China. Due to differences in perception and limitations of disciplines in academy and practice circles, understanding of the connotation, implementation protocols and approaches of the sponge city are divergent, which hinders the research and implementation of the sponge city. Based on the identification of basic urban water-related problems, this study illustrated the scientific connotation of the sponge city, and proposed the protocols of sponge city construction. Through a systematic review, this study proposed three substantial contents, three diagnosis items, three basic approaches and three balance equations of the sponge city. The fundamental philosophy is matching the sky area with the ground area. A systematic formula that covers all elements and all processes of general sponge city construction is presented. This study may provide the foundation for research, planning and implementation of the sponge city.

Key words: sponge city; urban water issue; construction pattern; urban hydrology; urbanization

Annual Report

2018

CHINA INSTITUTE OF WATER RESOURCES AND HYDROPOWER RESEARCH

Daxing Experimental Base

Management Achievement

The 60th Anniversary of IWHR

On October 18, 2018, the day of IWHR's 60th anniversary, the institute organized the Forum on Modern Water Governance and Technological Innovation that was attended by the Minister of Water Resources of China, Mr E Jingping, with a speech stressing the new Chinese water governance principles of "prioritizing water conservation, balancing spatial distribution, taking systematic approaches and giving full play to the roles of both government and market"...

IWHR organizes Forum on Modern Water Governance and Technological Innovation in celebration of its 60th anniversary

Minister of Water Resources E Jingping

Vice Minister of Water Resources Lu Guihua

WWC President Benedito Braga

IWHR President Kuang Shangfu

Plenary session

International contribution award

Keynote speeches

Bilingual staff performance

Academic Sessions

Modern water governance & innovation

The Forum on Modern Water Governance and Technological Innovation was held on October 18, 2018 to have 18 speakers from a dozen countries presenting national cases around 4 topics, including integrated water resources management, ecological protection, ICT and water-food-energy nexus...

Water efficient use & new civil engineering technologies

The International Symposium on Efficient Utilization of Water Resources and New Technologies of Civil Engineering was held during October 18-19, 2018 that attracted over 200 participants -- including 15 Chinese and foreign academicians -- from 17 countries...

Roundtable of water-related international organizations

The Round-table Meeting of Leaders of Water-Related International Organizations, hosted and co-organized by 15 international organizations, was held on October 17, 2018 in Beijing, in which three topics were well discussed and a declaration on sustainable water development was signed...

East Asia dam conference

The 10th East Asia Dam Conference was held in Zhengzhou city in central China from October 15 to 16, 2018 with 820 Chinese and foreign participants and a theme of promoting dam safety and river health through green and high-quality construction management...

African roundtable meeting

The 11th African Round Table Meeting on Sustainable Development of Hydropower, aiming at promoting the ICOLD World Declarations and share experience with African experts, was organized on October 16, 2018 in Zhengzhou...

Cross-straits youth camp

The 6th Cross-Straits Youth Camp on Water was held in Beijing during October 16-23, 2018 as a platform for young professionals from across the Taiwan Straits to exchange and learn from each other through lectures and site visits...

Symposium on water system operations

The International Symposium on Water System Operations was held on October 17, 2018 to provide a multi-disciplinary platform for exchange and bring into play the influence of the newly-established IAHR Water System Operations Working Group...

Cross-straits symposium on water sciences and technologies

The 22nd Cross-Straits Symposium on Water Sciences and Technologies, a regular exchange mechanism launched in 1994, was held during October 19-20, 2018 that focused on water management, ecological protection, flood control and information technologies...

Belt and Road world youth forum

The Belt and Road World Youth Forum, jointly hosted by IWHR, Global Water Partnership (GWP) and GWP China, was organized on October 19, 2018 in Beijing and attended by about 50 delegates from 14 countries...

Modern hydropower forum

The International Forum on Modern Hydropower, hosted by International Hydropower Association (IHA), was held on October 19, 2018 in Beijing with a theme of managing sustainability, digitalisation and climate change...

Flood management forum

The International Forum on Flood Management, sponsored by International Conference on Flood Management (ICFM), was held in Beijing with a theme of "Integrated Flood Risk Management in a Changing Environment"...

Technical tour

Technical tours were arranged on October 19, 2018 to the Yongding River Restoration Project and the Tuancheng Lake regulating reservoir of the South-to-North Water Diversion Project...

Highlights of 2018

1

IWHR celebrates its 60th anniversary with week-long academic events attended by the Minister of Water Resources who in a keynote speech pointed out for the first time the principle contradiction in water governance and work priorities in a new era.

2

IWHR hits a record high in newly-signed contracts with a 16.08% increase to CNY 1.559 billion in 2018, with its revenue up 11.83% to CNY1.796 compared to the previous year.

3

IWHR makes substantial innovative achievement and wins 4 national awards, 50 provincial-level awards, and 319 patents, with patents for invention up 57% to 127.

4

IWHR plays an increasingly important role in supporting water resources reform by submitting proposal and investigation reports on national strategic projects such as water security, rural area invigoration and the protection of the Yangtze Economic Belt.

5

IWHR creates new drivers for the development of young talents, reaping a bunch of influential awards, including the 12th Guanghua Science and Engineering Award, Qian Zhengying Hydraulic and Hydroelectricity Award for Scientific Innovation, the 3rd Special State-Sponsored Program for High-Level Talents, the 6th Distinguished Hydraulic Science Talent Award, and the 2018 Chinese Government Friendship Award.

6

IWHR attains qualification for enrolling international students. Its Graduate School starts receiving international students from December 2018.

7

IWHR releases its top 10 list of institute-level laboratories, forming a hierarchical innovative research platform system that consists of key labs at national, ministerial, institute level and departmental levels.

8

IWHR is rated Class A engineering consultant in the first credit evaluation in 3 research disciplinaries, including water resources and hydropower, electricity (including thermal power, hydropower, nuclear and new energies), and ecological and environmental engineering.

9

IWHR makes great progress in promoting organizational culture through such activities as holding special seminars and staff training, and wins multiple honors including Model of Organization Culture of the Capital.

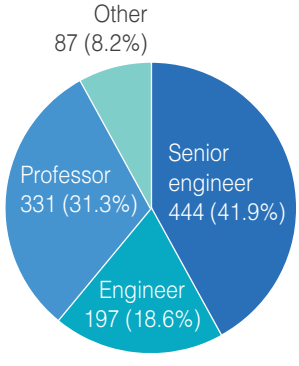
10

IWHR completes the upgrading and data migration of its portal website with integrated and uniform standards, technical platform, security protection, operation, supervision, and cross-site information sharing.

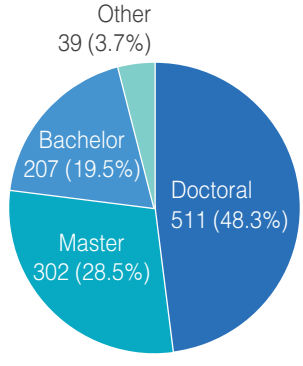
Statistics

Human Resources

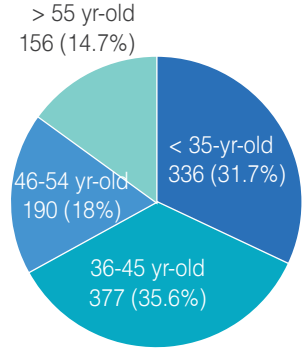
By the end of 2018, IWHR has 1059 technical professionals.



By title



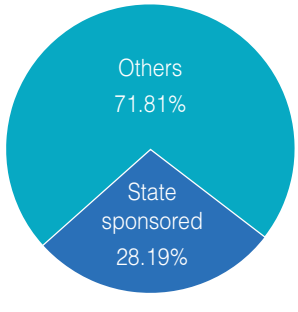
By educational level



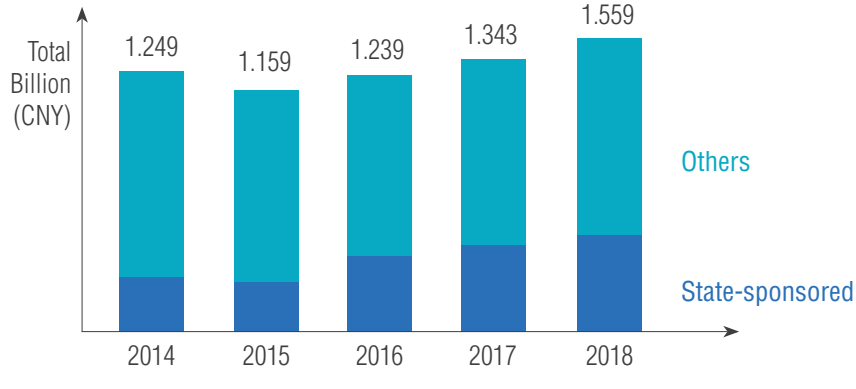
By age

Research Contracts

Research contracts signed in 2018: CNY 1.559 billion in value.



- National 69.94%
- Ministry of Water Resources 26.79%
- Other ministries 2.75%
- Local governments 0.52%



Awards

In 2018, four completed researches are granted state level prize and 50 on provincial/ministerial level.

Type	Amount	Grade
State level	4	Second prize (4)
Provincial or ministerial level	50	Special prize (4)
		First prize (19)
		Second prize (19)

Some of the prized researches:

- The Impact of Climate Change on Regional Water Resources and Droughts and the Key Technology for Risk Response
- Key Technology for Concrete Cutoff Wall under Ultra-deep and Complex Geological Conditions
- Key Technology for Safety Control of 300m Extra High Arch Dam and Its Engineering Application
- Key Technology for Hydraulic Ship Lifter and Its Application
- Research and Practices of Key Technology for High Concrete Dams
- Research on the Flood Detention and Sedimentation Function of the Bankfull Area and Disaster Reduction Technology for the Flood Plain Area of the Lower Yellow River
- Key Technology for Life-Cycle Performance Evolution Mechanism and Safety Control of High RCC Dams
- Innovation and Application of Complete Sets of Technologies for Hydraulic Ship Lifter
- Fertigation and Precision Control Technology for Micro and Sprinkling Irrigation and Its Large-scale Application
- Research on Intelligent Assessment and Diagnosis Technology for Hydropower Units and Its Application
- Key Technology for Investigation and Evaluation of Flash Floods in China and Its Application
- Key Technology for Monitoring, Regulation, Control and Disposal of Water Pollution Emergencies in the Middle Route of South-to-North Water Transfer Project
- Laser Controlled Land Fine Leveling Technology and Its Promotion and Application
- Key Technology for Operation Risk Management and Control of Large-scale Water Transfer Projects and Its Application
- The Evolution of Underground Water Resources, Key Regulation Technology and Practices in China
- Research on Key Technology for China-Kazakhstan Transboundary Water Resources Development and Utilization and Engineering Regulation Capacity
- Key Technology for Intelligent Construction of RCC Dams in Alpine Regions
- Ecological Hydraulic Regulation Theory, Key Technology and Application of River Habitat Restoration
- Development and Application of the Yellow River Water-sand-ice Transfer Model Base and Standard Setting and Simulation System
- Research and Application of Key Technology for Reclaimed Water Irrigation in Agriculture, Forestry and Landscaping
- Key Technology for Super High Arch Dam Construction in Massive Earthquake Areas and Its Application in Dagangshan Project
- Stability Control Technology for High-seismic intensity, Deep-unloaded, Complex and High-slope Areas
- .....

Intellectual Properties

IWHR obtains 319 patents in 2018 (including 127 inventions and 192 utility models), participates in the editing of 9 technical codes, and also publishes 38 books and 559 papers.

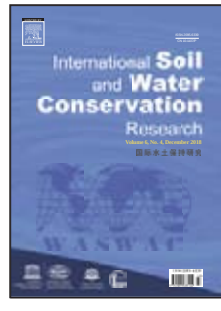
	Patents		Technical codes		Books	Papers
	Inventions	Utility models	Chief-edited	Co-edited		
Amount	127	192	5	4	38	559

Journals

Journal of Hydraulic Engineering

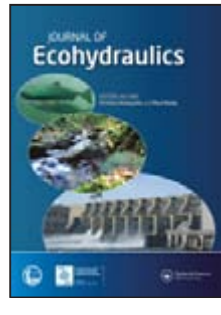
Journal of China Institute of Water Resources and Hydropower Research

International Journal of Sediment Research



International Soil and Water Conservation Research

China Flood and Drought Management



Journal of Ecohydraulics

Journal of Sediment Research

Mechanical & Electrical Technique of Hydropower Station

International Cooperation

International Exchange

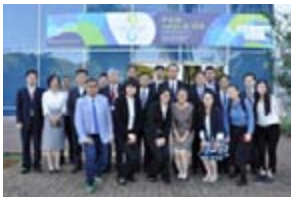
A Delegation Led by the Danish Minister of Environment and Food Visits IWHR and Exchanges Ideas on Sino-Danish Strategic Cooperation Project

The Polish Minister of Marine, Economy and Inland Navigation Visits IWHR and the Automation Monitoring Laboratory

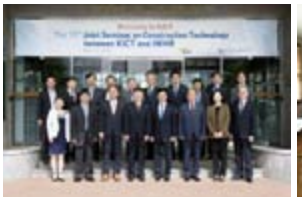
A Delegation Led by the Secretary-General of the Ministry of Water, Land and Natural Resources of Malaysia Visits IWHR

A Delegation Led by the President of the International Commission on Irrigation and Drainage (ICID) Visits IWHR

Nigeria South-South Cooperation Technical Training Group Participates in a Training Course at IWHR



Chinese Water Experts Delegation Participating in the 8th World Water Forum



15th IWHR-KICT Joint Seminar on Construction Technology

Academic Exchange at University of Montana, U.S.

Overseas Technical Visit in Ecological Restoration Field under the Auspices of China-Europe Water Platform (CEWP)

IWHR Experts Conduct Field Research on Typical Groundwater Recharge Projects in Copenhagen

Experts from the Mekong Countries Conduct a Technical Visit to the Shanxi Reservoir in Zhejiang Province

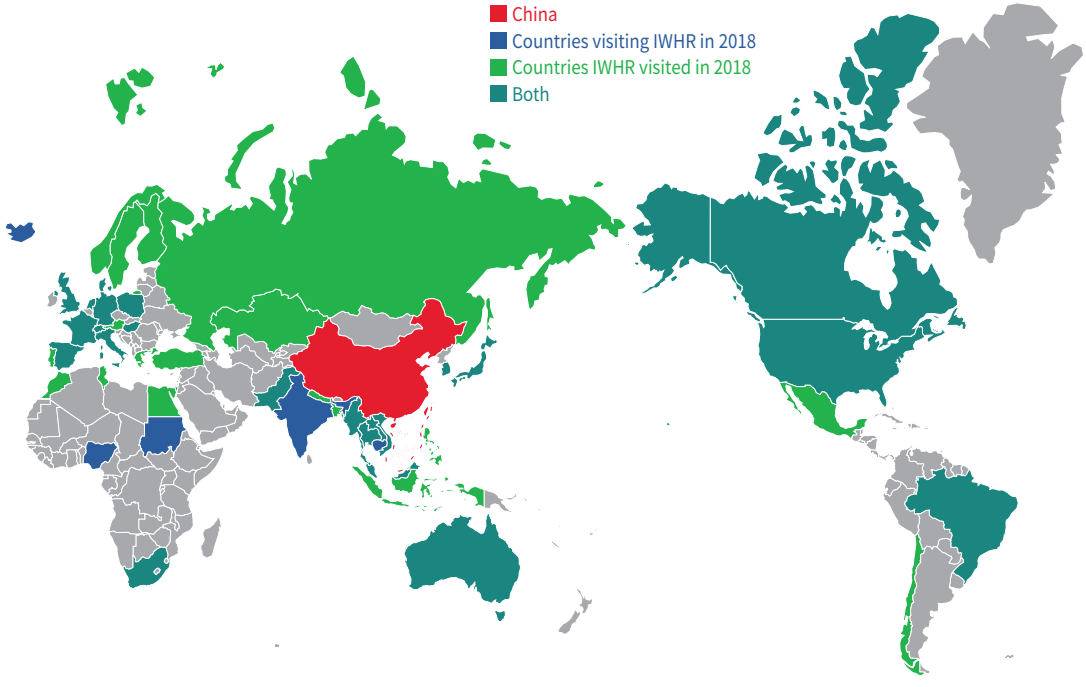
China's Irrigation Projects Listed into World's Heritage Irrigation Structures

Field Investigation to the Abutment Excavation Site of the Mellegue Dam, Tunisia

IWHR's Foreign Expert Receives the Chinese Government Friendship Award

Partnership with Cooperative Agreements

2018 IWHR Global Footprints



Annual Report

2018

CHINA INSTITUTE OF WATER RESOURCES AND HYDROPOWER RESEARCH

Yanqing Experimental Base

Appendix

Organizational Structure

President and Vice Presidents

Commissions	• Academic Commission • Board of Professional Title Assessment	• Board of Academic Degree Assessment
Administrative Divisions	• General Office • Division of Personnel, Labor and Education • Division of Research, Management and Planning	• Division of International Cooperation • Division of Finance and Assets Administration • Division of Supervision and Audit
Research Departments	• Department of Water Resources • Research Center on Flood and Drought Disaster Reduction *(including the Remote Sensing Technology Application Research Center and the Department of Water Resources History)* • Department of Water Environment • Department of Irrigation and Drainage • Earthquake Engineering Research Center	• Department of Geotechnical Engineering • Research Center for Sustainable Hydropower Development *(including the Department of Structures and Materials)* • Department of Sediment Research • Department of Hydraulics • Department of Water Resources for Pastoral Areas
Division of Comprehensive Business	• Graduate School • Standardization Research Center	• Information Center
Enterprises	• Beijing IWHR Corporation • Beijing IWHR Technology Co., Ltd. • Beijing IWHR-KHL Co., Ltd.	• Tianjin Institute of Hydroelectric and Power Research • Beijing Zhongshui Runke Certification Co., Ltd.
Secretariats of International Organizations	• World Association for Sedimentation and Erosion Research (WASER) • World Association of Soil and Water Conservation (WASWAC) • Chinese National Committee on Large Dams (CHINCOLD) • Chinese National Committee on Irrigation and Drainage (CNCID)	• International Association for Hydro-Environment Engineering and Research (IAHR) • Global Water Partnership (GWP) China • China Office of International Hydropower Association (IHA) • International Conference on Flood Management (ICFM) • China River Restoration Network (CRRN)

Research Divisions

Department of Water Resources

Fundamental and applied research on the theories and applications in hydrology and water resources, including the fundamental theories and simulative technologies of water cycle, the assessment, planning, allocation, saving, regulation, management, protection and macro-strategy research of water resources, and the consulting and international cooperation in related fields.

Research Center on Flood and Drought Disaster Reduction (incl. the Remote Sensing Technology Application Research Center and the Department of Water Resources History)

Research on key issues of flood control, drought relief and disaster reduction, including disaster formation mechanism, forecasting and warning, risk assessment, management and rescue technology of risk and emergency, application of remote sensing and other high-technologies, water resources history and water culture.

Department of Water Environment

Evolution mechanisms and simulation technologies of water environment and ecology; methods and standards of assessment and monitoring, as well as protection and recovery technologies of water environment; guarantee technologies of drinking water safety; environmental impact assessment of projects; theories and information technologies of water environment management.

Department of Irrigation and Drainage

Strategies, planning and related standards of water resources development in rural areas; water-efficiency irrigation and management technologies of farmland water and soil environment; research, equipment development, transfer, promotion and application of water supply technologies in rural areas; quality inspection and product certification of equipment.

Earthquake Engineering Research Center

Theories and analysis method of earthquake engineering; the arch dam and gravity dam seismic research; dynamic test of structures and equipment; monitoring and forecasting of reservoir earthquake; anti-earthquake analysis and safety assessment of electrical and nuclear power equipment.

Department of Geotechnical Engineering

Property study of geotechnical materials; behavior simulation, safety assessment and centrifugal testing of geotechnical structures such as embankment dams, high slopes and underground tunnels and chambers.

Research Center for Sustainable Hydropower Development (incl. the Department of Structures and Materials)

Strategies, policies, planning and key technologies of sustainable hydropower development, including theories, methods and assessment system of hydropower sustainability (green hydropower); strategic planning of hydropower development; ecological protection and reservoir resettlement policies of hydropower projects. Thermal stresses and temperature control of hydraulic structures; numerical, visual and digital simulation of projects; safety monitoring and inspection of projects; anti-seepage, repair and reinforcement of projects.

Department of Sediment Research

River channel evolution and improvement; reservoir sedimentation and regulation; conservation and control of water and soil; sediment issues in estuary, coastal and hydraulic projects; prevention and control of sediment disasters; fundamental theories and simulation technologies of sediment movement.

Department of Hydraulics

Hydraulics of high-velocity flow, flow-induced vibration and project layout; hydraulic control and ice dynamics; cooling water and cooling tower research for thermal and nuclear power projects; river and ecological hydraulics; hydraulic prototype observation and equipment development.

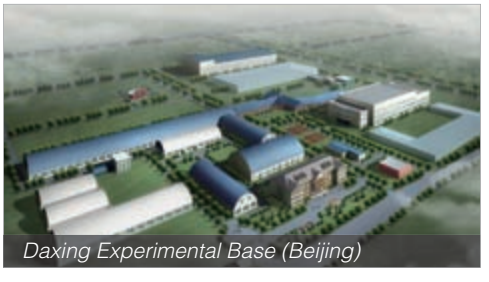
Department of Water Resources for Pastoral Areas

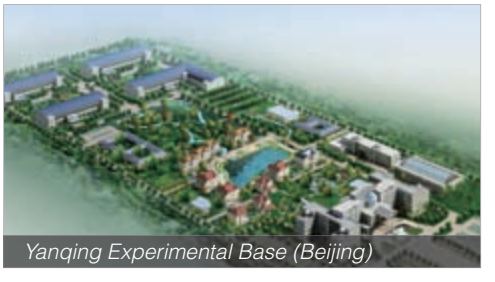
Water resources and water environment for pastoral areas; water-efficiency irrigation and drainage, conservation of water and soil, and ecological recovery of grasslands; clean energy development and utilization, as well as water supply equipment, for pastoral areas.

Scientific Research Bases

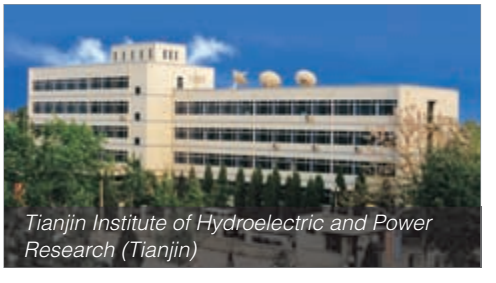

Technology Innovation Base (South, Beijing)


Technology Innovation Base (North, Beijing)

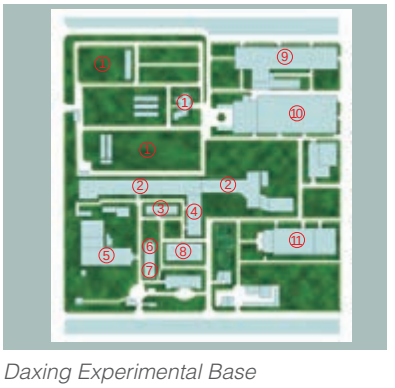

Daxing Experimental Base (Beijing)


Yanqing Experimental Base (Beijing)


Base of Water Rescources for Pastoral Areas (Inner Mongolia)


Tianjin Institute of Hydroelectric and Power Research (Tianjin)

Laboratories in Daxing and Yanqing bases include:



Daxing Experimental Base

Yanqing Experimental Base

(1) Laboratory of Water Cycle and Deployment
(2) Laboratory of Water-Sediment Regulation and River Training
(3) Laboratory of Soil and Water Conservation
(4) Laboratory of Fundamental Theoretical Research on Sediment Transport
(5) Laboratory of Hydraulics
(6) National Center for Efficient Irrigation Engineering and Technology Research - Beijing
(7) Laboratory of Rural Drinking Water Safety, NCEIR
(8) National Center for Quality Supervision and Test of Agricultural Irrigation and Drainage Equipment
(9) Laboratory of Hydraulic Regulation
(10) Laboratory of River Environment
(11) Hydraulic Machinery Laboratory
(12) Laboratory of Geotechnical Centrifuge
(13) Laboratory of Flood Control and Disaster Reduction
(14) Laboratory of Automatic Control and Simulation
(15) Comprehensive Laboratory of Mechanics
(16) Comprehensive Laboratory of Water Resources and Soil & Water Conservation Engineering

Large Equipment

Vacuum tank (vacuum percentage 98.7%; flow discharge 1.0 m³/s)

Universal test stand of advanced hydraulic machinery model

LXJ-4-450g-t geotechnical centrifuge

Tri-axial earthquake simulating shaking table with 6 degrees of freedom

15000 KN universal testing machine

Creep testing system for fully-graded concrete

Hydraulic flume and water tank

Eddy covariance system

Multi-functional GC-MS Machine

IWHR

Application Brochure for International Students

Graduate Education

IWHR started its graduate education in the 1950s and has excellent research facilities and equipment, a large number of cutting-edge research projects, adequate research funding, numerous literature resources, and a top-notch team of graduate supervisors (175 master's supervisors and 91 doctoral ones). After more than 6 decades of exploration and development, IWHR has established a complete and unique system of graduate education.

Degree Programs in English

8 programs for master's degree and doctoral degree:

- Geotechnical engineering
- Hydrology and water resources
- Hydraulics and river dynamics
- Hydraulic structure engineering
- Hydraulic and hydropower engineering
- Hydro-environment
- Hydro-informatics
- Water disaster and security

The applicants must satisfy one of the following language requirements:

- Graduates from universities of English-speaking countries;
- Graduates from universities where English is the official language;
- TOEFL: 68 (internet-based test)/ IELTS: 5.5.

Duration of study:

- 3 years for both the master's degree and doctoral degree.

Fees

- Application Fee: Free in 2019
- Annual Tuition: CNY 26,000-CNY 39,000
- Annual Accommodation: CNY 12,000- CNY 24,000
- Annual Insurance: CNY 800

Scholarships

IWHR outstanding international student scholarship

In 2019, scholarships of up to CNY 93,800 per year are available for outstanding applicants, including all or part of the following items:

- Waiver of the fees of tuition, accommodation and medical insurance;
- Living stipend of up to CNY 42,000 per person per year.

How to Apply

General information

- Application is open only to non-Chinese citizens who are in good health.
- Educational background and age limit.
- The applicant for a master's program must be under the age of 35 and has a bachelor's degree.
- The applicant for a doctoral program must be under the age of 40 and has a master's degree.

Application Methods

- Email to iwhrgraduateoffice@163.com.
- Post or submit in person application documents to the Office of International Student Affairs of IWHR Graduate School.

Required application documents

- See details at http://www.iwhr.com/IWHR-English/index.htm.

2018 Annual Report of IWHR
Published on March 30, 2019

Beijing IWHR Corporation

Scope of business

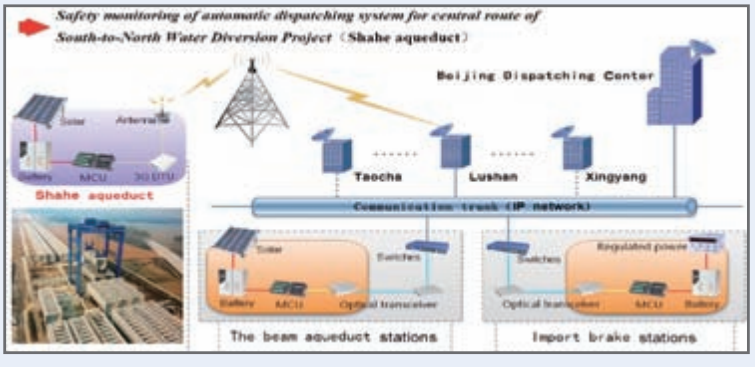
- Consulting, design and equipment development of safety monitoring and automation system
- Foundation anti-seepage, reinforcement and treatment
- Inspection, diagnosis and assessment of project health
- Hydraulic Elevator Dam and Rubber Dam: R & D, manufacturing, installation, engineering contract, technical consulting; Water Sector: irrigation, drinkable water safety, water supply and drainage, and pump station; at the same time, we self-operate and agent the import and export of varied goods and technology, etc.
- General contracting (EPC) of overseas hydropower projects
- Complete set of electromechanical equipment and technical services in hydropower station
- Vibration testing, dynamic response simulation and safety assessment of hydraulic turbine and powerhouse

Representative products/projects

Leakage plugging project for Daping Hydropower Station in Yunnan Province

Hydraulic Elevator Dam in Dunhua, Jilin Province

Rubber Dam in Myanmar



Safety monitoring of automatic dispatching system for central route of South-to-North Water Diversion Project

Beijing IWHR Technology Co., Ltd.

Scope of business

- Study, design, development & turnkey of SCADA&system of simulation for hydropower stations, windfarms, solar power stations,projects of water diversion & irrigation, etc.
- Electro-machinery engineering technology for hydropower stations
- Experimental study of prototype, condition monitoring of hydropower generating units
- Study &integration of automation system of water regime forecasting and dispatching for hydropower stations &river basin
- Study, development & turnkey of management system of information for water utilities
- Design & manufacture of hydro turbine governors& auxiliaries

Representative products/projects

- EPC of electro-machinery equipment for hydropower projects, Bac Binh, Bayramhacili, etc.
- H9000 system of supervision& control for hydropower stations, Three Gorges, Xiluodu, etc.
- OTS2000 3D simulator for operator training for hydropower stations, Xiluodu, etc.
- HR9000 automation system for water regime forecasting&water dispatching, Ertan, etc.
- DVG2000 governors for hydropower stations, Tishrin, Fengtan, Zexi, etc.
- Experimental research of hydro-turbine models, Three Gorges, Xiluodu, Xiangjiaba, etc.
- Diagnostics of hydropower generating units, Three Gorges, etc.

H9000 system of supervision & control, condition monitoring system, experimental study of hydro-turbine model for Three Gorges Project

EPC of generating units for Bac Binh HydropowerStation

Radar water level gauge for Ertanhydropower station

Spillway of Bayramhacili HydropowerStation

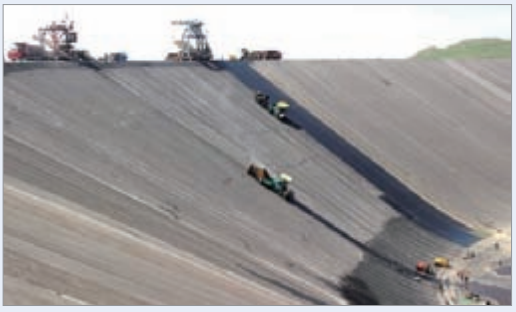
Beijing IWHR-KHL Co., Ltd.

Scope of business

- Research, development, manufacturing and integral construction of waterstop materials
- Research, development and manufacturing of hydraulic concrete and macromolecular materials
- Inspection, safety assessment and technical consulting of hydraulic structures
- Repair and reinforcement of hydraulic structures
- Research, development, manufacturing and construction of hydraulic bituminous concrete materials

Representative products/projects

GB waterstop materials have been applied in more than 100 hydropower stations in and outside China, including Shuibuya Hydropower Station. Our company has conducted optimization of concrete mixing and performance test for over 100 hydropower stations, including the Three Gorges Project. We have also completed the inspection, safety assessment, repair and reinforcement of a large number of hydraulic structures, as well as the construction of bituminous concrete face for the upper reservoirs of many pumped-storage power plants.



Construction of bituminous concrete face for the upper reservoir of Hohhot Pumped-Storage Power Plant in Inner Mongolia

Surface waterstop construction for the concrete face of Liyuan Hydropower Station in Yunnan Province

Inspection and safety assessment for the central route of South-to-North Water Diversion Project

Optimization of concrete mix and performance test for Xiluodu Hydropower Station

Tianjin Institute of Hydroelectric and Power Research

Scope of business

- Efficient hydraulic-model of hydraulic machinery (pump) technology
- Automatic component (device) manufacturing technology
- Integrated control system technology
- Smart grid device
- Power transmission and distribution equipment
- Debugging and installation guidance and transportation of the products we offered

Representative products/projects

Efficient hydraulic-model of pump

Axial pump

Energy-saving rollover flap valve

Mobile hydraulic driven pump unit

Water circulation pump for high Temperature and Pressure

Salt chemical circulation pump

Double micro-computer (PLC) static excitation system for synchronous generator

Filter reactor

Harmonic control system

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