State Key Laboratory of Hydraulics and Mountain River Engineering Sichuan University



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Outline

Authorized by National Planning Board (NPB) in May 1988, the State Key Laboratory of Hydraulics and Mountain River Engineering became the first approved State Key Laboratory in hydraulic engineering field.

Since 1952, the discipline of Hydraulics and River Dynamics has been selected as the key construction disciplines in Sichuan University, and then it was selected for the first batch of doctoral program in China in 1981 before it was approved firstly as the state key disciplines of hydraulics in China in 1988. Furthermore, it is approved as the first batch of Chang Jiang Scholars Program in 1998. Then, in 2000 hydraulic engineering discipline becomes the first-level discipline awarding doctoral degree. Moreover, in 2005, basing on the laboratory, the construction of the "985 Project" Technology Innovation Class I platform was approved by the Ministry of Education. Up to now, the Laboratory has three state key disciplines (Hydraulics and River Dynamics, Geotechnical Engineering and Solid Mechanics), three first-level disciplines awarding doctoral degree (Hydraulic Engineering, Mechanics, Environmental Science and Engineering) and three doctoral programs (Geotechnical Engineering, Structural Engineering and Ecology).

The overall goal of the laboratory can be summarized as the following three points: (1) to construct world-class academic platform for engineering hydraulics and mountain river field; (2) to promote our technological innovation, personnel training and academic exchanges in the Hydraulics and Mountain River area in China; (3) to support water conservancy and hydropower project construction and disaster prevention in mountain river. With the construction of high-level research team and modern public platform, distinct characteristics of the laboratory have been formed in the following research areas: high dam hydraulics, sediment dynamics in mountain rivers, water environment in high dams and large reservoirs, dam and reservoir bank security and intelligent scheduling of cascade hydropower stations.

Research Achievements

In recent 5-years, the Laboratory has undertaken 362 national major engineering research projects, covering the hydropower stations with the world's highest technical indexes, such as Jinping First Stage Hydropower Station, Jinping Second Stage Hydropower Station, Xiluodu Hydropower Station, Xiaowan Hydropower Station, Shuangjiangkou Hydropower Station, and Huangdeng Hydropower Station. The Laboratory also undertook national key projects including Xiangjiaba Hydropower Station, Baihetan Hydropower Station, Wudongde Hydropower Station, Nuozhadu Hydropower Station, Pubugou Hydropower Station, Zipingpu Hydropower Station, etc. The Laboratory has solved a series of scientific and technical problem from engineering design to operation, playing an irreplaceable role in the scientific and technological development of this research field. Both the scientific and technical achievements in our laboratory have been recognized nationally, for instance, the laboratory has received 1 second prize of national technological innovation award, 4 second prize of national scientific and technological progress award, 9 first prize of provincial or ministry technological innovation award and scientific and technological progress award. During the same period, the Laboratory has published 182 papers indexed by SCI, 225 papers indexed by EI, and 13 monographs. The Laboratory has also been conferred 83 national invention patents, 5 American invention patents, and 8 software copyrights. The Laboratory has participated in drafting 5 volumes of technical specifications and standards.

For more details, the Laboratory has made outstanding research achievements in the following five research areas that are closely related to high dam project safety and mountainous river health issues.



1: Flush prevention and erosion reduction mechanism and technology in high dam projects



In this field of research, innovative achievements or inventions have been made such as the

Collision-free Hierarchical Distributed Jet Flow Technique, the Adaptive Multi-stepped Overflow technique, the Classified Shaft Spin Flow technology, the Multi-stage Expanding and Shrinking technique for erosion prevention, the Single-stage Flush Prevention and Erosion Reduction technique and the New Turbulent Modeling Method and et al.

2: Generation mechanisms of extreme flood and sediment disasters prevention technology



The generation and cumulative mechanisms of mountainous floods and sediment disasters have been revealed. Academic achievements have been made mainly in the aspects of sediment and debris flow disasters, river confluences and compound channel problems. Especially, we have developed a unified calculation method of flow capacity in mountainous compound channels. In addition, a method to calculate the additional resistance in mountainous intersected channels has also been developed.

3: Response mechanism of ecological environment to watershed hydropower development



Hydropower is a clean energy resources, attracting more and more attentions to its development. However, adverse environmental and ecological problems can be resulted during its development. In order to deal with these problems, a set of experimental devices to reveal the generation and release mechanism of total-dissolved-gas over-saturated flow and its effects on aquatic lives, especially the fishes have been developed. In addition, achievements have been made for the transport mechanism of density flow under temperature stratification condition and its operational numerical models, and a methodology for thermal exchange coefficient of ice water in reservoirs. A unique fish spawning index system of hydraulic habitat has also been developed.

4: Mechanical response characteristics of rock structures and project safety evaluation techniques



Generally, the major academic achievements are made in: 1) a joint network reconstructions method to reveal the statistical rule of strength and the failure mechanism; 2) The catastrophic energy theory of rock damage; 3) large deformation mechanism of high stress rock; 4) new control technology of underground cavern deformation and 5) reliability evaluation technique of project safety. Moreover, new findings have been obtained in the following two aspects:

(1) Disaster investigation of Wenchuan earthquake between 2008 and 2009

Before 2008 the Longmenshan fault belt had been considered mild, however Wenchuan earthquake totally overturned the above vision! The quake reminds us that our knowledge on active faults is limited and in disaster reduction it should be prudent to use the earthquake intensity estimation based on limited historical records.

(2) Mechanism of reservoir landslides

The research focused on the conflict between theoretical prediction and actual statistical data on the landslides in reservoir areas. Statistics shows that most of reservoir landslides occur during reservoir filling; however the prediction based on saturated / unsaturated soil mechanics tells us that reservoir impoundment is beneficial to bank stability. The research addresses the importance of geological structures and thinks that confined water pressure plays an important role in bank stability.

5: Efficient utilization of water resources in watershed cascade development in southwest areas



A new method of set pair analysis and wavelet analysis for runoff sets has been proposed. Automatic recognition and selection, adaptive model parameters calibration for prediction model and method of optimum runoff have been realized. A decision support system for the watershed management of cascade hydropower stations has been developed.

The major research challenges

> High-speed flow hydraulics and high-dam engineering

Targeting the safety of flood discharging in highdam engineering, the challenges in this research field include new technology of flood discharge and energy dissipation from high-dams, high-speed air-water twophase flow characteristics and their engineering impacts, prediction and control of cavitation, new aeration



techniques for cavitation reduction under large water head and flow rate, and optimal design of hydraulic structures for flood discharging in high-dam engineering.

> Mountain river dynamics and mountain river engineering



Targeting the mitigation of mountain river hazards, the challenges of the researches include bed-load transport for broadly graded sediment in Mountain Rivers, physical and numerical modeling of river sediment transport and its engineering applications, bed morphology in complex river channels with vegetation, the mechanism of hazard generation and mitigation

strategies to prevent flash floods in mountainous regions.

Environmental hydraulics and mountain river protection

Targeting the environmental protection in hydraulic and hydropower engineering, the challenges of this research include environmental hydraulics in large deepwater reservoirs, prediction of pollutant transport and fate in water, impact of hydropower projects on environment and ecology, ecological restoration techniques, ecological water demand in rivers and ecological water management in reservoirs, and water quality monitoring technology and equipment development.





Dam and reservoir bank safety

Targeting the safety of high dam and its foundation, researches should be emphasized in this field include fundamental theories of rock mechanics; instability mechanism of steep and high side slope, physical and numerical modeling of high-dam and foundation stability, monitoring and management of dam safety, and mechanism

of landslide in reservoir and its prevention.

> Hydro-informatics and new technology in hydraulic engineering.

Targeting the intelligent operation of hydropower engineering, researches should be concentrated include numerical simulation of complex turbulent flows in hydraulic engineering, optimal theory and technique of water management in cascade hydropower stations, and construction management of hydraulic and hydropower projects.

