

CHINCOLD Publication

Studies on Modern Technology of Rock-fill Dam Construction and Hydropower Development

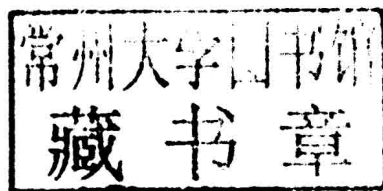
Li Jugen Jia Jinsheng Ai Yongping Zhang Zongliang



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Preface I

The global increase in population, and the socio – economic development with increasing living standards for all, will inevitably raise the demand of water, food and energy. Meanwhile, due to global climate change, water distribution will become more uneven in both temporal and spatial domains, and disasters related to floods and droughts will worsen. Facing such a serious situation, for the whole world, building dams and developing hydropower shall be an inevitable option to realize sustainable socio – economic development and to build an energy – efficient, environment – friendly harmonious society.

Regarding the situation in China, from the perspective of energy utilization, oil is in short supply and coal is dominant in China's energy structure. However, excessive dependence on coal will not only lead to exhaustion of resources, but also result in severe environment problems due to the extensive CO₂ emission. Therefore, China's energy development strategy shall not only to contain energy development scale in future, but also to clarify the energy structure. Renewable energy with hydropower as the dominant shall be given higher priority in future's energy development in China.

From the perspective of water resources management, China is a country with shortage of water resources and frequent floods and droughts as well as uneven temporal and spatial water distribution. With the rapid socio – economic development and continuous population growth, contradiction on supply and demand of water resources in China will have radical changes. Floods and droughts have delivered extensive threats to China's food safety and drinking water safety. Due to the characteristics of China's climate and geography, the problems cannot be sufficiently solved only by natural adjustment of the rivers. To realize optimized allocation of water resources, it is necessary to build reservoirs, dams, and interbasin water transfer projects.

Therefore, it is indispensable to build reservoirs and dams in perspective of the situation either in the world or in China.

After experiencing rapid development in past decades and particularly in recent years, China's dam construction has made well – known achievements in concepts on dam engineering, dam technologies and the scale in dam building, etc. Other countries in the world have also made great achievements in terms of dam construction. In order to share new technologies and experiences on dam construction and management and hydropower development, and to discuss new problems and thoughts, Chinese National Committee on Large Dams (CHINCOLD) and China Society for Hydropower Engineering (CSHE) will jointly sponsor "Hydropower 2013, CHINCOLD 2013 Annual Meeting and the 3rd International Symposium on Rockfill Dams" in November 2013 in Kunming, Yunnan Province. The conference is the following event of Hydropower 1996, Hydropower 1998, Hydropower 2004, Hydropower 2006, and CHINCOLD Annual Meetings in 2011 and 2012. It is also the extension of the 1st and 2nd International Symposiums on Rockfill Dams. The conference covers comprehensive aspects and will surely result in positive influences.

With the support of experts, scholars and related units, and by careful reviews of relevant experts, 90 papers are accepted and included into the Proceedings. Hereby, please allow me, on

behalf of CHINCOLD, to express my sincere appreciation for your support and participation!

The papers are categorized into the following topics:

1) Sustainable development of hydropower and environment – friendly technologies for dam construction;

2) Design and construction of high dams;

3) Dam safety assessment and rehabilitation technology;

4) Cases and engineering experiences of rockfill dams;

5) Design and analysis of rockfill dams;

6) Material and construction method of rockfill dams;

7) Operation, maintenance and monitoring of rockfill dams.

Looking into future's development in the 21st century, China is still facing extremely extensive missions in building and managing reservoirs and dams. While playing their major functions in flood control, irrigation and others, water projects shall also play a better ecological function. In future, during the process of design, research, construction, operation and management, attention should be constantly paid to the ecological function of water projects. Therefore, efforts should be made to fully increase the construction and management levels of reservoirs and dams. I sincerely wish the proceedings will lay a sound foundation for the success of the conference, and offer valuable references for decision – makers, investors, designers, researchers and engineers in the water resources and hydropower sector.

The conference is organized by Huaneng Langcang River Hydropower Co. , Ltd, HydroChina Kunming Engineering Corporation, and China Institute of Water Resources and Hydropower Research. At the same time, great support is offered by Brazilian Committee on Large Dams, State Grid Corporation of China, China Renewable Energy Engineering Institute, China Datang Corporation, SINOHYDRO, China Anneng Construction Corporation, China Gezhouba Group Corporation, Yellow River Water – hydropower Development Corporation, Yunnan Jinsha River Hydropower Co. , Ltd, Dadu River Hydropower Development Co. , Ltd. , CPI Yunnan International Power Investment Co. , Ltd. , Changjiang Institute Of Survey, Planning, Design and Research, Sinohydro Engineering Bureau 8 Co. , Ltd. , Collaborative Innovation Center of Hydraulic and Transportation Infrastructure Safety-Henan Province, International Hydropower Association, International Society for Soil Mechanics and Geotechnical Engineering Large Dam Technical Committee and China Society for Hydropower Engineering Concrete Face Rockfill Dam Committee. Hereby, please allow me to express my sincere appreciation to all of them!



Wang Shucheng

President of CHINCOLD

Former Minister of the Ministry of Water Resources of China

Beijing, October 2013

Preface II

Hydropower resources are clean renewable energy. All the countries in the world attach great attention to advancing sustainable hydropower development. It is widely acknowledged around the world that hydropower has huge advantage in energy conservation, emission reduction and climate mitigation. Active development of rich hydropower resources plays a significant role for China to increase clean energy proportion, improve energy structure, ensure national energy safety and water safety, meet power demand growth, reduce greenhouse? gas? emissions, protect ecological environment etc. Sustainable hydropower development is very important for promoting sustainable development of economic society.

Hydropower is the second largest conventional energy resource in China. The theoretical reserve of hydropower resources is about 694 GW and annual energy output of 6 080 TWh. The technically exploitable hydropower is 542 GW, equivalent to annual energy output of 2 470 TWh. Since the latter half of the 20th century, hydropower construction in China steps into rapid development track, a large batch of world – class hydropower projects are constructed and a large amount of worldwide leading technology are developed in China. Especially since 21 century, the party (CPC) and state pay great attention to rational development and utilization of hydropower resources in China, hydropower industry keeps uninterrupted development. In 2004 and 2005, the installed hydropower capacity and annual hydropower production of China both ranked first in the world. Since 2003, the newly installing capacity is increased by more than 10 000 MW every year. At present, the total installed capacity of hydropower in China has exceeded 250 GW. According to incomplete statistics, China has built more than 500 large and medium – sized hydropower projects, more than 3 000 large and medium hydropower generating units are put into operation. There are approximate 46 000 small hydropower stations, and over 5 200 dams higher than 30 meters built or under construction in China, in which 150 or more dams are higher than 100 meters. China has caught up with the world and become a major hydropower country and a hydropower power from a smaller hydropower country. It not only ranks first in hydropower installation but also has the largest hydropower under – construction scale and the fastest hydropower development speed in the world.

After many years of endeavor, the hydropower scientific and technical work of China, guided with science and technology, initially breaks through the constraint of technology, capital and technical talents on the basis of engineering-oriented hydropower technical results and major national projects. Hydropower technology grows out of nothing, changes from following to leading, realizes great – leap – forward development. Design, construction, manufacturing, installation, operation, and management levels of hydropower construction rise sharply, hydropower construction and comprehensive management capacity reach internationally advanced level. In the course of construction of the remarkable Three Gorges Project for about 20 years, five key engineering technologies are broken through, ten difficult engineering problems are solved and a hundred or more of world – leading engineering technologies are innovated. In recent years, many technical innovations and breakthroughs in hydropower engineering come from the Three Gorges Project. This century project makes China

become a country from learning and catching up with the world advanced level to leading the worldwide hydropower technology trend.

China hydropower industry is speeding up implementation of the “Going out” strategy. In recent years, Chinese hydropower construction enterprises positively implement “Going – out” strategy based on strong technical force, rich and mature experience and huge human resources accumulated for decades. They have made achievements in about one hundred nations and regions in Asia, Africa, America and Europe, possessed more than 50% of global construction market share of water conservancy and hydropower and become leading and benchmarking enterprises in the water resources and hydropower construction industry of the world. Many large – scale, high – quality and high – efficient projects constructed by Chinese hydropower enterprises achieved wide range praises from local governments and people in the project – located countries. Thus Chinese hydropower enterprises have made a positive contribution to the worldwide hydropower development.

In the process of pushing forward hydropower development, all the countries in the world have made various achievements. In order to share new technology and experience of hydropower development, discuss new ideas and study new problems on hydropower development, China Society for Hydropower Engineering and China National Committee on Large Dams have held successfully many international hydropower seminars and conferences in recent years, and promoted wide communication and cooperation between China and other countries in the hydropower field. For this time, both parties will cosponsor “Hydropower 2013 – CHINCOLD Annual Meeting & the 3rd International Symposium on Rockfill Dams” in Kunming, China. This Symposium is got high attention from hydropower organizations, specialists and scholars, who contributed articles eagerly, both in China and abroad. There are about 160 papers received from Chinese and foreign participants and finally 90 papers are chosen for official publication after review of relevant experts. I would express my congratulations to the participants for their research achievements on behalf of China Society for Hydropower Engineering.

I hope, with the convene of the “Hydropower 2013 – CHINCOLD Annual Meeting & the 3rd International Symposium on Rockfill Dams” and publication of the symposium? proceedings, it could provide a broad platform for hydropower specialists and colleagues from China and abroad to show their hydropower achievements, share their progress results in technology and management, promote communication and cooperation in hydropower development and pursue sustainable hydropower development. Let us work together to cope with global climate change, advance clean and green energy development, benefit and make contributions to mankind.



Zhang Jiyao

President of CSHE

Former Director of Office of SNWD Project Commission of the State Council

Beijing, October 2013

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