Safety First

Managerial Achievements on Overseas Dam in Safety and Reservoir under Normal Operation

Yunnan United Power Development Co.,Ltd : Myanmar Shweli(1) Hydropower Station

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An Overview to Myanmar Shweli(1) Hydropower Station

1. Brief Introduction

☑ Located at Shweli River mainstream, adjacent to the Sino-Myanmar border, North Shan State, Myanmar
☑ Cascade No.1 of the three hydropower stations under planned of the river in Myanmar

☑ 6 power units put into operation up to April, 2009
☑ The first overseas BOT hydropower station under Huaneng Lancang River Hydropower INC, a subsidiary of China Huaneng Group Co., Ltd

Part 1 An Overview to Myanmar Shweli(1) Hydropower Station

Brief Introduction

☑ The power station head complex is located near Mantat Village, around 30km away from the Sino-Myanmar border, and distributed in a stream segment of around 8km between upstream around 1km of Nam Myin Ditch exit and downstream of Andrew Ditch exit, on the right bank of Shweli River.

☑ In the head complex area, the water current is turbulent, with continuous rocky beach, and water surface elevation drops more than 300m in a stream segment of around 8km, with high hydraulic slope and in an unbalanced V-shape valley , generally steep on the left bank and gentle on the right bank.

2. Project Scale

Based on the natural conditions, it is designed as a diversion-type power station, with power generation as main development purpose, and without other purposes such as anti-flood, irrigation, and shipping.

Installed capacity：6×100MW Normal storage level：725m

Dead level：717m Reservoir total capacity：2411×104m³

Reservoir capacity under the normal storage level:

only 1144×104m³

among them, regulated storage capacity 446×104m³

being a run-off-river incomplete daily regulated reservoir

guaranteed output：174.8MW Multi-year average

power generation volume: 4033GWh

Installed capacity hours utilized：6722h

Once built and put into operation, the power station shall transmit electricity to Myanmar and China Southern Power Grid, respectively via 230kV and 220kV transmission lines.

3. Major Structures

Shweli(1) Hydropower Station is a diversion-type station, mainly consisting of head complex, water-diversion system, and power house complex.

☑ Head complex

The power station complex area is near Mantat Village, around 30km away from Sino-Myanmar border, and distributed in a stream segment of around 8km between upstream around 1km of Nam Myin Ditch exit and downstream of Andrew Ditch exit, on the right bank of Shweli River.

☑ Water diversion system

Distributed on the right bank, consisting of water-diversion tunnel, upstream surge shaft, and penstock (built-in).

☑ Powerhouse complex

including ground main powerhouse, auxiliary powerhouse, and indoor GIS booster station

Major Structures

Popular Science

Diversion-type station :

Select the river segment with steep sloping and concentrated elevation drops, and utilize a gentle sloping water diversion tunnel to fulfill the required elevation drop (water drop).

4. Timeline for Major Works

Construction Commencement:

15 February, 2004

Shweli(1) Hydropower Station

01 10 December, 2006
River closure

02 9 April, 2007
Grout the first tank concrete for the dam

03 30 June, 2008
Grout up to Dam crest Elevation 735m

04 31 July, 2008
Construction fully completed

05 5 September, 2008
The first set of power unit put into operation

06 April, 2009
All 6 power units put into operation

An Overview to Myanmar Shweli(1) Hydropower Station

Timeline for Major Works

At initial construction phase of the power station

Completion Inauguration of Shweli(1) Hydropower Station

[2]

Safety Status of the Dam and Side Slope

1. Safety Evaluation of the Dam
2. Natural Disaster and Treatment at the Water Intake Side Slope

1. Safety Evaluation upon the Dam

☑ Evaluation time

January, 2019 to July, 2021

☑ Evaluation content

Conduct a objective evaluation upon the designed standard of the dam, dam structure, flood discharge and energy dissipation, anti-seepage performance of the dam, safety and reliable operation of the gates, safety monitoring system, as well as side slope performance of key works etc. Relevant problems are fixed.

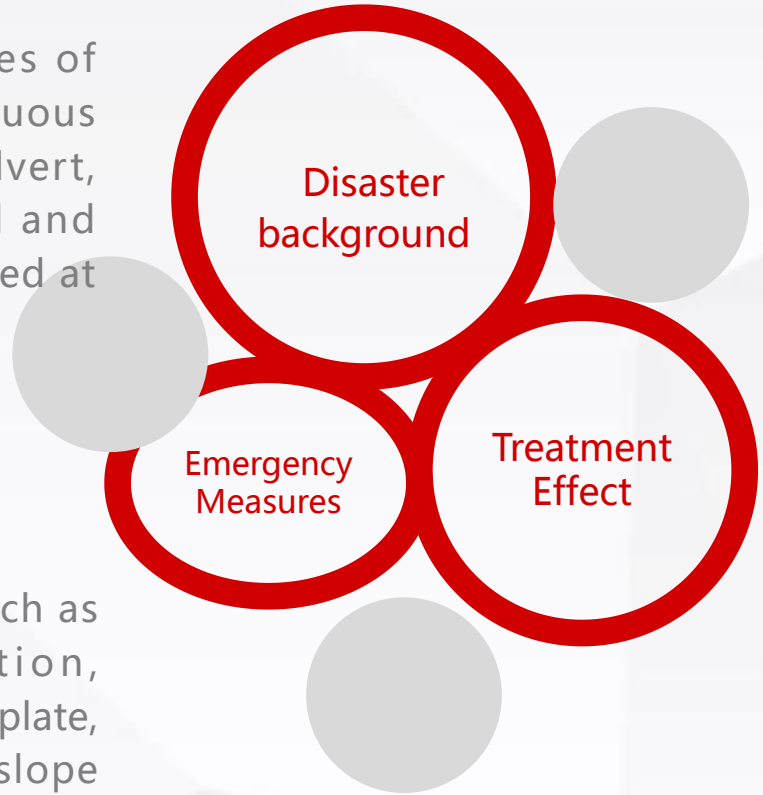
Topic work：jobsite checkup, special checkup upon the flood discharge and sand flushing facilities, check the dam operation status and conclude a comprehensive analysis report, conduct a study upon flood recheck and the operation dispatching plan etc, appraisal upon the safety monitoring system and analysis upon the monitoring data, as well as analysis upon the working performance of sideslope of key works.

Significance of evaluation: Shweli(1) Hydropower Station is the first time to carry out the evaluation since put into operation. Through evaluation, the dam of Shweli(1) Hydropower Station is a nomal dam (A-grade).

2. Natural Disaster and Treatment at the water Intake Side Slope

In early August,2017, under series of unfavorable factors such as continuous raindrop, poor drainage of the culvert, underground water concentrated and earthquake, a natural disaster erupted at the water intake side slope

A series of measures were taken such as slope cutting and load reduction, prestressed anchor rope plus anchor plate, anti-slide piles, drainage culverts, slope shoring by lattice beam, water interception and drainage facilities.



☑ Underground water drops obviously at water intake side slope

☑ Surface deformed quite little, showing convergence deformed.

☑ Deformation at deep place is measured, showing no mutation.

☑ Anchor rope forcemeter works stably

☑ All monitoring indexes are normal, and the side slope becomes stable.

The natural disaster was treated correctly and in a timely way, with no interruption to the normal power generation of the station.

Natural Disaster and Treatment at the Water Intake Side Slope

Within less than 2 years, the upper excavation area is through technical measures regained for vegetation cover, both project construction and environmental protection benefit are fulfilled.

[3]

Challenges and Measures for the Power Plant Reservoir under Normal Operation

1. Muddy and high-hardness natural watercourse leads to severe silting-up in the reservoir.
2. Effective measures for long-term treatment

Challenges and Measures for the Power Plant Reservoir under Normal Operation

1. Muddy and high-hardness natural watercourse leads to severe silting-up in the reservoir.

01

Problem:

• Sediment accumulation in the reservoir, high muddy operation throughout the year

02

Manifestation:

• Multi-year average suspended sediment 8,760,000 tons, sediment concentration 0.76kg/m³, with high-hardness quartz sand Grade 7 contained.

• Especially in rainy season (June to October) : average flow rate 646.5m³/s, sand flow rate 607kg/s, sand content 0.939kg/m³, multi-year average debris bed load 876,000 tons

03

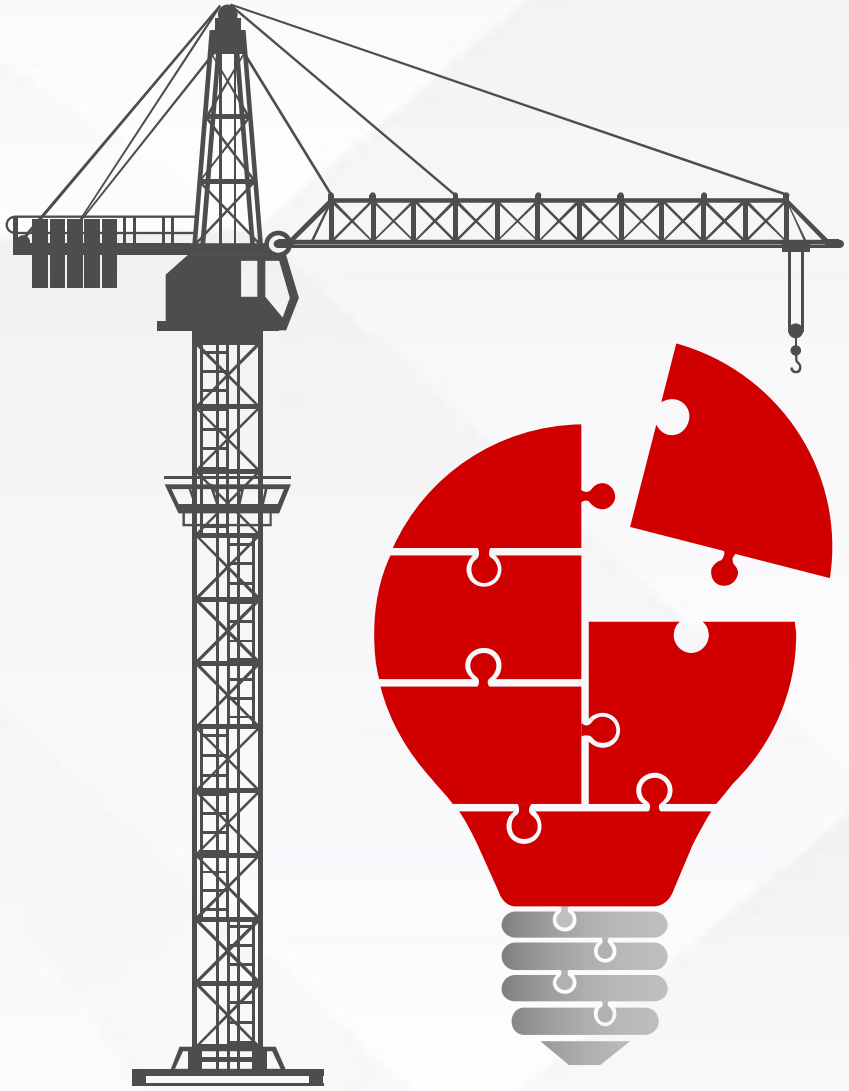
Unfavorable impact:

· Constant accumulation of sediments leads to decreased reservoir capacity.

· Overhigh differential pressure appears at the water intake debris barrier plus the reflux design for adding water at water intake lead to turbulent water current, and forming a vortex.

· Plenty of sediments through hydroturbine will directly wash out and damage the water passing components of hydroturbine generating unit.

2. Effective measures for long-term treatment



Measures: 1) Actively explore the routine sediment discharge and sourcing sand flushing work

- The design institute made a design for the reservoir against sediments, and drafted a Design Report on Sourcing Sand Flushing of Myanmar Shweli(1) Hydropower Station.
- Since 2012, the power station was kept with continuous flood discharge and sand flushing, and every 2 or 3 years, organize a sourcing sand flushing so as to ensure the water intake in clean status.

Effective measures for long-term treatment

Measures: 2) Keep track of the operation status of the equipment and facilities in the reservoir area, strengthen technological innovation, and sustainably explore management innovations.

- In May, 2020, combined with the multi-year operation experiences, Kunming Survey Design Institute was entrusted to draft the Normalized Sand Flushing Plan of Shweli(1) Hdyropower Station.

>>Advantages<<

1）Consolidate the sourcing sand flushing achievements, reduce power unit shutdown, and increase economic benefit

2）Effectively fix the high-mud sediments, and restore the regulating capacity of the reservoir.

3）Reduce the sediments through the machine, and prolong the hydro-turbine life.

4）The reservoir operation and dispatching management become higher efficient, safer , and more convenient.

Effective measures for long-term treatment

Stable retaining wall during sand flushing

- From rainy season in 2020 up to Year 2021, the power station in succession organized to complete the low water-level operation of the reservoir in rainy season, as well as testing and verification work for normalized sand flushing without shutdown.

- The n**ormalized sand flushing plan is a further optimization to the sourcing sand flushing report**

At Shweli(1) Hdyropower Station, practice shows that normalized sand flushing can efficiently solve the problem of mud sedimentation, which develops a new thought for high-mud run-off-river station.

Gentle water flow during sand flushing

[4]

Summary of Management Innovations in Terms of Station Operation & Management

1. Operation and management achievements on reservoir joint dispatching with the upper stream station
2. Self-developed rapid cold restoring technique for the water passing components of hydroturbine
3. Successfully solve the key problem on Trash removal in deep flowing water at water intake
4. Successfully explore and solve the strangle problem on normalized sand flushing

1. Operation and management achievements on Reservoir Joint Dispatching with the Upper Stream Station

The upstream and downstream reservoir data in contrast

	Upstream (Longjiang HPP)	Downstream (Shweli(1) HPP)
Normal water level	872.00m	725.00m
Dead water level	845.00m	717.00m
Capacity below the normal water level	$11.31\times10^8m^3$	$1144\times10^4m^3$
Regulated capacity of reservoir	$6.79\times10^8m^3$	$446\times10^4m^3$
Regulating capacity	Incomplete annual regulating	Incomplete daily regulating

（◁ Left Picture: Top View of Upstream Longjiang Dam）

To fully use the inflow water, Shweli(1) Hydropower Station invited the Design Institute to study the joint dispatching of reservoir water, and actively built a shared information mechanism. Through multi-year practice, a new pattern of joint reservoir water dispatching was formed in 2019, with obvious benefit achieved. In 2020, Shweli(1) Hydropower Station achieved its record maxmal economic benefit, and the total volume of power generation reaches 3814GWh.

2. Self-developed rapid cold restoring technique for the water passing components of hydroturbine

—— Innovation Achievement Title Granted by China Scientists Forum

a) Research background

1) The river in the territory of Myanmar flows through complex geological environment. Sediments in water contains:

High-hardness quartz sand

2) Water passing components of hydroturbine are severely worn-out due to the following four high levels:

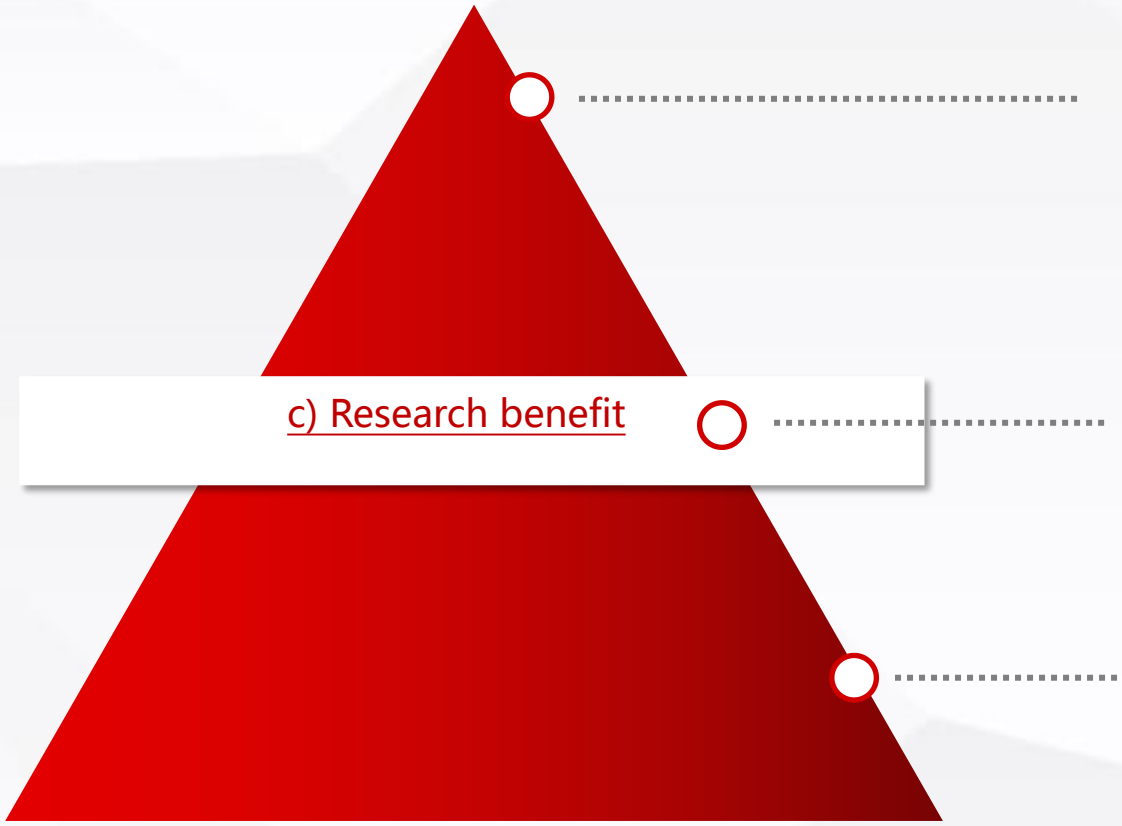
- High water head (300m)
- High rotation speed (428r/min)
- High sediment
- High hardness (up to the hardness level of quartz sand)

获奖奖章

b) Significance

The subject team developed a rapid restoring “cold” material with excellent physical and chemical properties. This material shows a series of merits such as excellent performance against cavitation erosion, firm adhesion strength, low safety risk, no deformation, high wear resistance, and easy to operate.

Self-developed rapid cold restoring technique for the water passing components of hydroturbine



1) Meet the application requirements, compared to the traditional tungsten carbide painting technique, this rapid "cold" technique owns a lot of merits such as short restoring time, little damage to the parent material, good performance against cavitation erosion;

2) Solve such problems as adhesion strength out of control, low internal strength of the restoring material, long time for solidification;

3) Play a good role in protecting the parent material of the water passing components, prolong the equipment service years, extend the replacement period of the water passing components, and thus ensure high-level power generation proceeds.

3. Successfully solve the key problem on Trash removal in deep flowing water at water intake

a) Research background

Concerning the trash clean-up problem in deep flowing water, under the condition without similar solutions in the field, our company plans to carry out research as follows:

1) To determine a parallel-move trash cleaning machine easy to operate, so that our operator can stay at any position to observe, remote control and conduct operations;

2) Aiming to the characteristics of the trashes, to determine the impact force of the grab bucket, and the grating bearing capacity;

3) To determine the working radius and the grab bucket strength.

Old trash cleaning machine

New **trash cleaning machine**

b) Significance

Make definite the specification of the new-type trash remover, visit quite a few manufacturers domestially, and finally determine the automatic movable grating trash remover. This trash remover owns such characteristics as follows:

1) Unique design of travelling guide rails, which can meet the requirements at different positions;

2) The guide rails are installed with a limit sensor, which can control the travelling cart to stop at each grabbing place;

3) When grabbing, the grabbing teeth are closely engaged with the bars. Through this function, hair-like sewage and entangled objects can be removed;

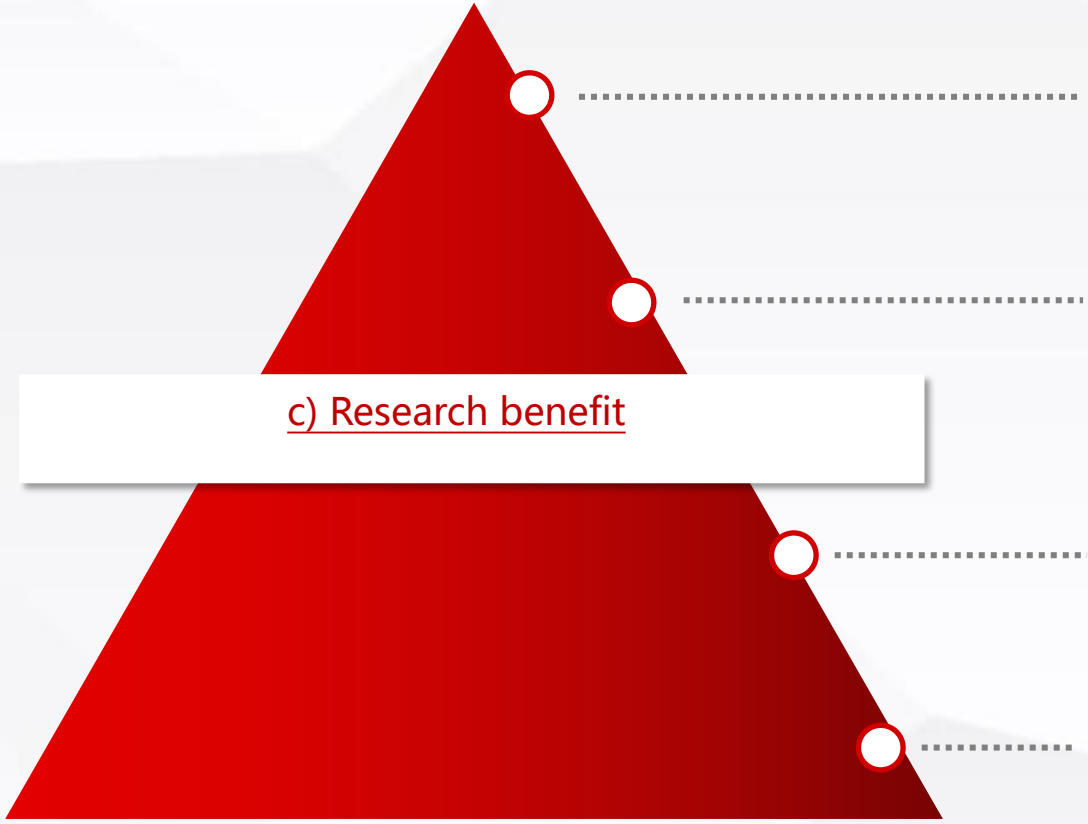
4) The rails crosses the water intake place, and the control cable are also arranged along the rails.

Successfully solve the key problem on Trash removal in deep flowing water at water intake

Performance in contrast between the new trash remover and the old trash remover

Types in contrast	Rotating grating trash remover	Steel-rope grating trash remover	GD-series movable grating trash remover
Wastes disposal type and capacity	small scale for waste disposal	small or middle scale for waste disposal	all scales for waste disposal
Working area	one machine for one water intake	one machine for one water intake	one machine for a few water intakes
Applicability (width and depth)	width less than 4m, depth less than 10m	width less than 4m, depth less than 10m	no limit to width, depth 40m
Structure performance	Some components are always immersed in water, which are easy to be worn-out.	Some components are always immersed in water, with high noise when rotating.	No components are always immersed in water, uneasy to be worn out.
Maintainability	Poor maintainability	Good maintainability	Good maintainability
Garbage discharge	Wastes shall be conveyed via a conveyor device to the collecting field.	Wastes shall be conveyed via a conveyor device to the collecting field.	Wastes can be directly conveyed to the collecting field.
Requirements for civil engineering	high requirements for civil engineering construction, high cost	high requirements for civil engineering construction, high cost	low requirements for civil engineering construction, low cost
Cost Performance	middle	low	high

Successfully solve the key problem on Trash removal in deep flowing water at water intake



1) The first power station which applies the movable trash remover in deep flowing water;

2) Perfectly solve the problem of less bearing capacity of the traditional trash removal ;

3) Operator can work without space limit. With intelligent control, no hidden place for clean-up;

4) GD-type grab bucket can meet requirements of waste removal in water of 35m deep, creating high power generation proceeds.

4. Successfully explore and solve the strangle problem on normalized sand flushing

a) Background

• Turbulent water current in front of the water intake during sourcing sand flushing;

• Floating-tank debris barrier is easy to become tilted influenced by water current;

• Operators are required to hang or untie the floater body on the floating tanks. It is a waste of labor force, difficult to operate, and with high risks.

Floating-tank debris barrier tilted in operation

Successfully explore and solve the strangle problem on normalized sand flushing

b) Solution

1) Investigation and study commences from Year 2017. Modification of light-weight debris barrier was completed in 2019 in terms of self-buoyance, free maintenance, and low water-level suspended function.

2) By taking the chance of sourcing sand flushing in 2019, build a new reinforced concrete retaining wall under the hoist working bridge of the service access door of flood discharge and sand flushing tunnel, which cuts off the water adding channel from under such bridge to the water intake, and improves the water flow state at water intake.

Modified as light-weight debris barrier

Successfully explore and solve the strangle problem on normalized sand flushing

c) Significance

Through the recent two-year joint reservoir dispatching and normalized sand flushing, the strangle problem on sediments is solved, which lays a solid foundation for normalized sand flushing of the power station in the years to come.

Independent hanging of the light-weight debris barrier

Stable water flow at water intake

That's all.

Thanks for Watching

20 November, 2021