Japanese Dam Technologies Contributing to the World 2023

Tsuruda Dam

JCOLD

JAPAN COMMISSION ON LARGE DAMS

It's our honor to introduce the following expertise

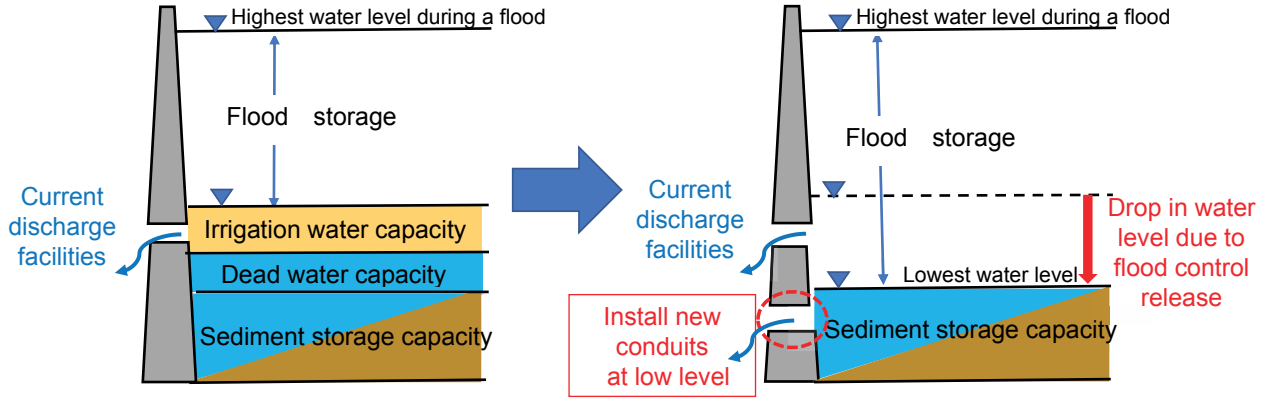
Advanced Technologies for Upgrading Dams under Operation

Japan's New Technology of Upstream Cofferdam Method
～Needs and Development background ～

By a social environmental change, the needs of dam are changed.

✓ More hydraulic power, More flood storage , etc

For these needs, it is necessary to install new conduits or penstocks in the dam body .



Able to use dead capacity in lower level of the reservoir to new purposes such as flood control .

New technologies of construction were demanded, safely in the full reservoir , in low cost, in a short term .

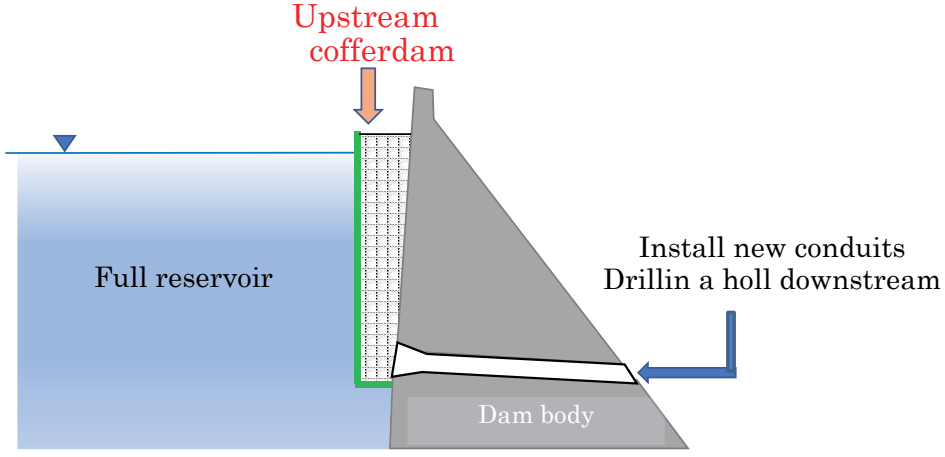
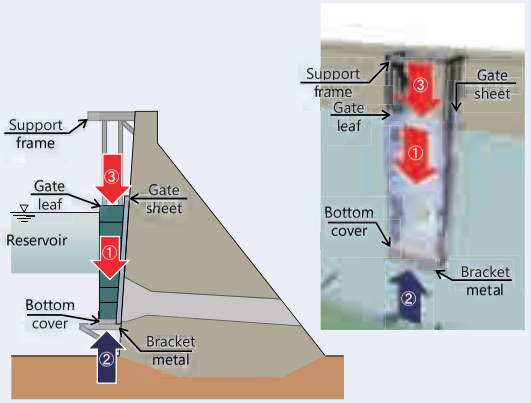
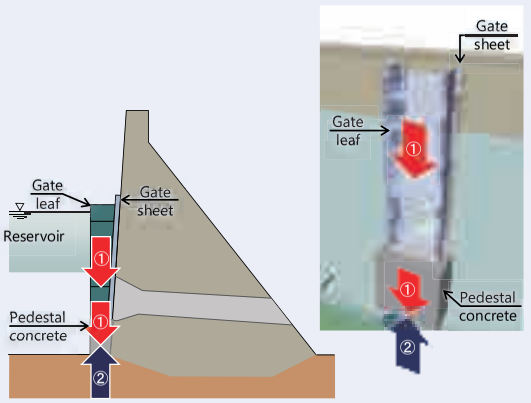
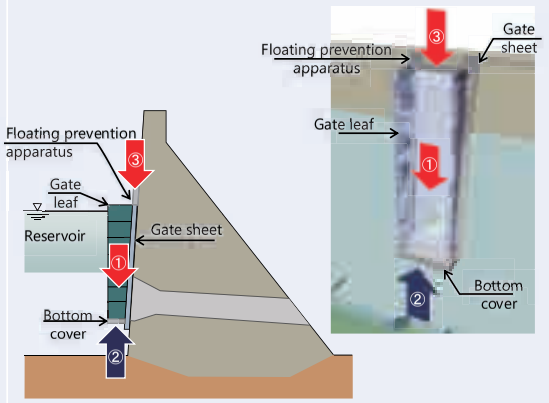


Image of the construction method

Comparison of upstream cofferdam construction method

Method of construction	Conventional construction method		New construction method Floating body system cofferdam
	Support frame system cofferdam	Pedestal system cofferdam	
Schematic diagram 【Major loads】 ① Dead Load ② Buoyancy ③ Support pressure			
Temporal structures for the buoyancy of the cofferdam during construction	Upper frame structure	Pedestal concrete (Deck)	Apparatus against floating
Installation method	**In-situ assembling of separated gate leaves** Each leaf is supported by anchors.	**In-situ assembling of separated gate leaves** The work includes prior excavation for the deck.	**Locating the integrated gate** The assembling of gate leaves is conducted in advance on the reservoir and tugged to the dam.

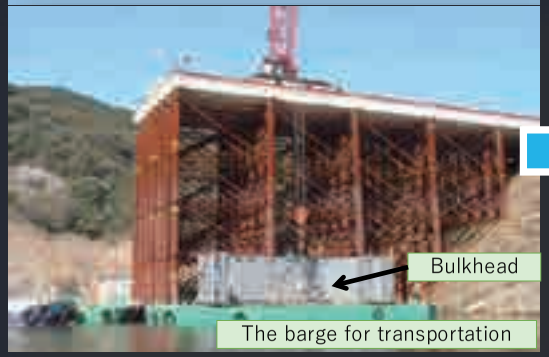
		Rank		Rank		Rank
Character of the installation	Less submerged work, Shallower work	B	Submerged work for much concrete placing, Deeper work	A	Least submerged work, Shallower work	S
Duration	Longer The work is conducted step by step.	B	Longer The work is conducted step by step.	B	Shortest Parallel construction is possible.	S
Possible leakage	More leakage due to in-situ assembling under water	A	More leakage due to in-situ assembling under water	A	Better watertightness thanks to the assembling in air	S
Impact to the dam	Much load on the dam crest part	B	Limited	S	Local impact around apparatus, easy access for inspection	S
Total weight of cofferdam and supported members	Much support members	B	Least weight in total	A	Not least. However, reuse to other projects is advantage.	S
Preparation work below the cofferdam	A little	B	Treatment of sedimentation and the foundation for the pedestal concrete	B	Unnecessary	S
Availability, restriction	Higher availability for lower water depth with less pressure of the buoyancy		No restriction in a dam height, water depth and clearance of the cofferdam.		No restriction in a dam height and water depth. Possibility of reuse for other projects.	

Rank of excellence: S > A > B

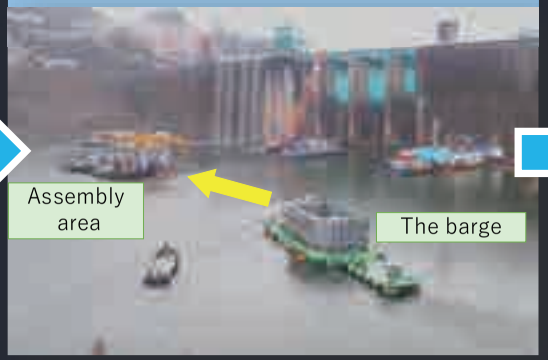
Floating Type Upstream Cofferdam Method —New Upstream Cofferdam Method—

The workability of the upstream cofferdam method can be significantly improved by airtight structure in each bulkhead to provide buoyancy

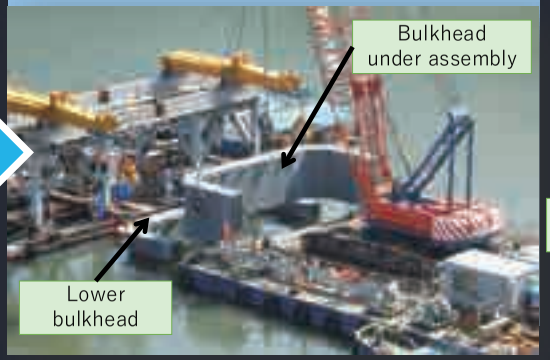
1.Loading of Bulkheads on the barge
—onto the barge on the reservoir—

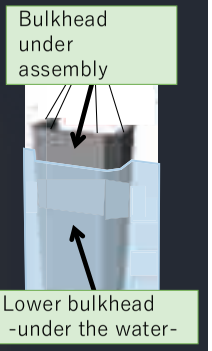


2.Transportation of bulkheads to assembly area by the barge
—reservoir transportation—

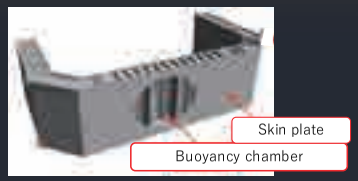


3.Assembly of bulkheads on the reservoir
—assembly of all bulkheads—

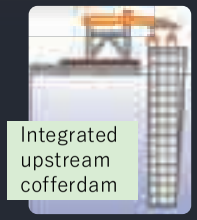




Overview of assembly

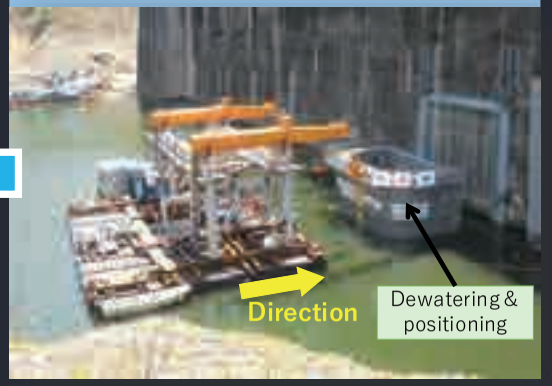


Overview of bulkhead



Overview of towing

4 .Towing & Installation
—dewatering from the upstream cofferdam for floating and positioning of the upstream cofferdam—



5.Dewatering from the upstream cofferdam
—securing a dry working space inside the upstream cofferdam—

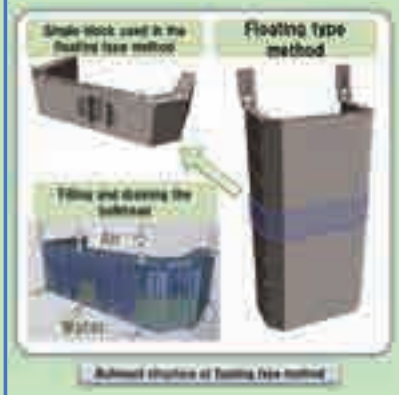
【Completion of Installation】

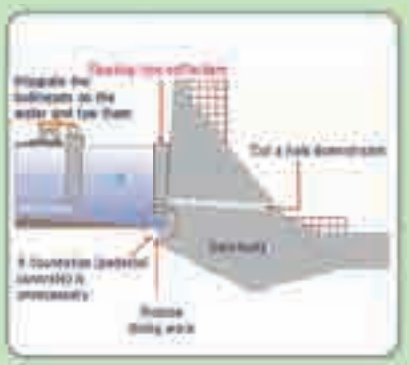
- Improved workability
- Safety improvement
- Shortened construction period
- Cost reduction

All work from assembly of bulkheads to installation of upstream cofferdam can be done on the reservoir

Floating type upstream cofferdam method

Overview of New Technologies





The cofferdam construction requires long diving hours at a very deep water depth, large temporary equipment, and a long construction timeframe.

For the floating type upstream cofferdam method, steel plates (skin plates) are attached to both the inside and outside of the bulkhead to make an airtight structure, and this becomes the buoyancy chamber to make the bulkhead float.
It is important to maintain the balance between buoyancy forces and dead weight by filling and draining the bulkheads blocks in the proper order.
And this new method was used for the first time in the Tsuruda Dam upgrading.

Construction Method

For actual construction, bulkhead blocks made at local factories will be assembled on the reservoir to standardize them and they will be towed to the installation position by a ship, and subsequently pulled by a winch and secured.
And then, water is drained from the cofferdam.

Efficiencies of the technologies

Efficiencies of this method :
This is dependent on scale of the cofferdam and construction depth, as large temporary facilities, such as pedestal concrete and support framework, are unnecessary and diving work can be greatly reduced, costs and processes can be reduced, and safety can be improved, leading to an increase in construction efficiency.
Moreover, when drilling holes in the same dam, it is necessary with conventional methods to dissemble and then reassemble the bulkheads, but with this method there is no need to disassemble the bulkheads; flood the cofferdam and detach the bulkheads from the dam-body and tow it as is to the next construction site where it can be installed.

Summary of the project

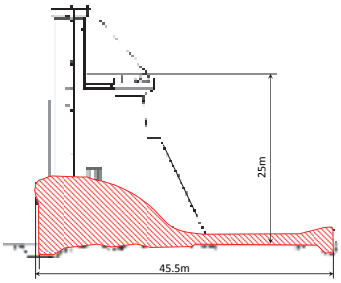
【Dam Specifications】
Type：Concrete gravity dam
Height：117.5m
Length：450.0m
Volume：1,119,000m³
purpose：flood control and power generation

The concept of the project is to increase flood capacity and discharge facilities.
The increase in flood storage will increase to a total capacity of between 75 million m³ and 98 million m³ by transferring the power generation capacity during flood season of 2.5 million m³ and dead water storage of 20.5 million m³, for a total of 23 million m³, to flood storage.The discharge facility was expanded to enhance discharge capacity by adding three conduit gates on the right dam-body (EL 115.6) at a location lower than the current discharge facility (EL 130.0) in accordance with the decline of the lowest water level.

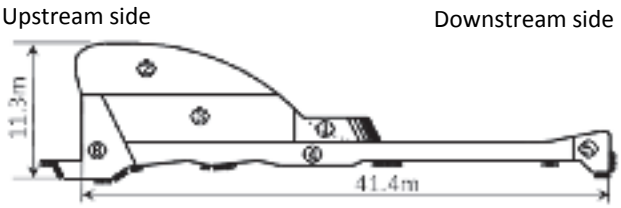
Controlled blasting technique with an electronic detonator

In the conventional blasting technique with a DS (decisecond-level) electric detonator, the gas created by the previous blast escapes through the construction joints before the next blast occurs, which makes this technique not suitable for concrete demolition. Therefore, by adopting the MS (millisecond-level) electric detonator, the next blast is successfully detonated before the gas escapes.

However, there were concerns about a blast vibration at private residence area exceeding the limit value set by management standard. Our solution was to deploy an electronic detonator (product name eDev II) and set one-hole one-step blasting with a time difference of 15 milliseconds, which enabled demolition blast to generate moderate vibration that was significantly lower than the standard limit value.



Part to Be Demolished by Blasting



Procedure of Demolition by Blasting

Drilling

Charging explosives

Blasting completion

【Characteristic】

· Time setting in arbitrary milliseconds for each detonator is possible on the spot.
· Time setting can be set in 1 ms increments within range from 0 to 20,000 ms.
· The precision of the set time is ± 0.1%.
· Includes safety devices to protect integrated circuits in the detonator from high voltage such as static electricity or induced current due to lightning strike.
· Includes a capacitor that stores the energy necessary for communication with the explosive device as well as for ignition.
· Each explosive device can detonate up to 500 electronic detonators.

This technique is effective in cases such as blast vibrations need to be suppressed, especially when other properties are in close proximity, or in when construction time is too limited to deploy conventional blasting technique.

【Regarding Environment, Surroundings, etc.】

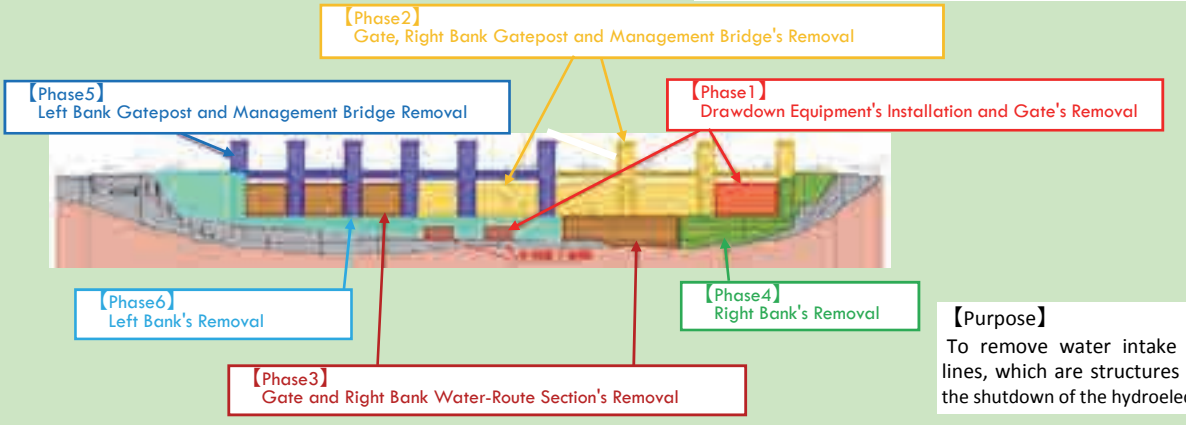
(Plan) Vibration level: not to exceed management standard value of 75 dB
(Actual) Vibration level: actual value of 61 dB (average)

【Future Prospects】

· Among controlled blasting methods for demolition, this technique is the most superior at present.
· In the introduced case, we set 15 ms as the time difference, however, we are still working on finding the optimal setting.

Work Description

【Dam】 Arase
【Type】 Concrete gravity dam
【Dimensions】 Height 25 m Length 210.8 m Volume 47, 167 m³
【Purpose】 Power generation

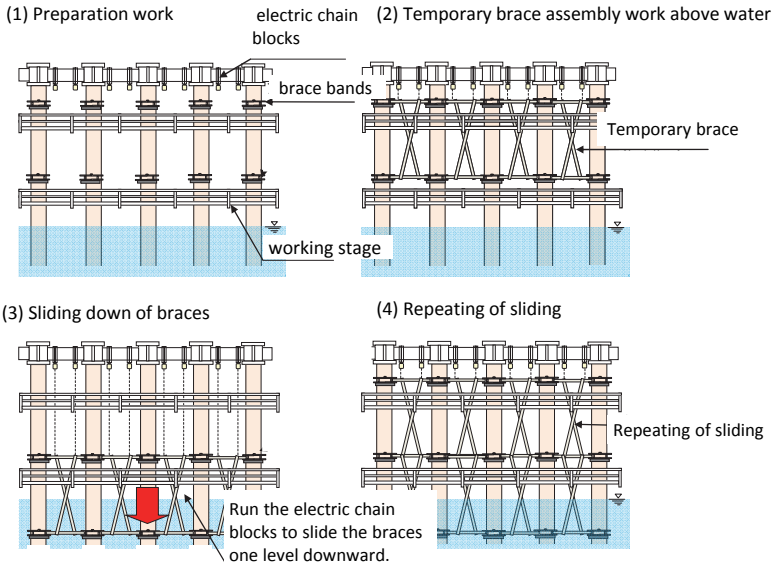


【Purpose】
To remove water intake facilities and drainage lines, which are structures inside the river, due to the shutdown of the hydroelectric power station.

LIBRA-S Method: Temporary piers oblique tie installation method

【Purpose】 To streamline the submerged brace installation work for temporary platforms.
【Background of selection of the method】
The brace installation work had been carried out using divers. However, the small range of visibility of the dam interior significantly harmed the work efficiency. The high turbidity of water after floods suspended the work for several days. Due to these, this work method to streamline the underwater operations was developed.
【Construction conditions】 Construction depth: 0 - 30m
【Outline of work method】
In constructing the substructure (brace) of a temporary platform, unit substructure members are assembled above water and slid downward and installed, thereby considerably reducing the diving operation.

- Most of the braces are assembled on stages installed above water, which reduces submerged operations, leading to an increase in the construction efficiency and safety.
- Once the work is completed, only bolts are loosened under water then the substructure members are collected in succession and demolished above water. This also results in higher safety and efficiency.

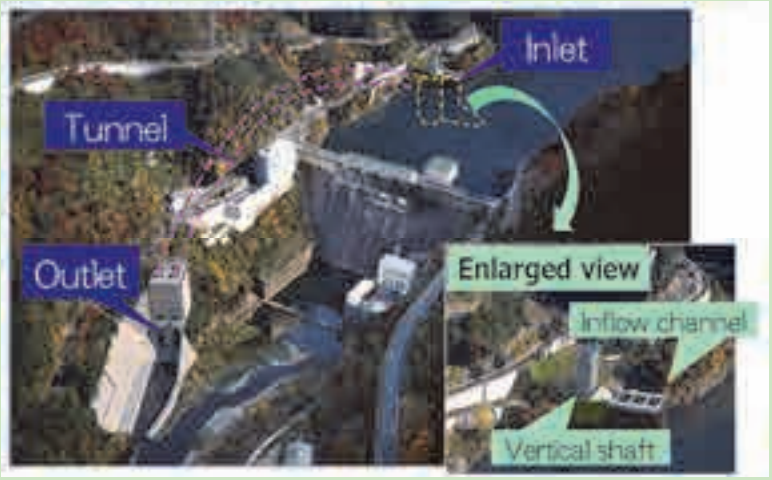


(1) Preparation work
Install a hanging working stage above water.
Mount electric chain blocks onto the upper structure girder.
Tie brace bands onto steel pipe piles to couple braces and steel pipe piles.
(2) Temporary brace assembly work above water
Install horizontal and diagonal members.
Hook the chain on a hanging jig on the upper horizontal members.
(3) Sliding down of braces
Run the electric chain blocks to slide the braces one level downward.
(4) Repeating of sliding
Repeat the above steps from tying brace bands in (1) to the rest.

Summary of the project

【Dam】 Kanogawa dam
【Type】 Gravity concrete dam
【Specifications of the dam】
Height：61m、 Crest length：167.9m、 Volume：161,000m^3
【Purpose】
Flood control、 hydropower

【Purpose of work】
A tunnel spillway will be constructed on the right bank of the dam in order to increase the flood regulation capacity of the existing Kano River Dam 1.4-fold.
Tunnel spillway:
Standard finished inner diameter: 11.5m; maximum cross section of excavation: 320m^2



Source: Ministry of Land, Infrastructure, Transport and Tourism, Shikoku Regional Development Bureau pamphlet

Full Rotation and Full Casing Method

【Purpose】To bore holes for installing steel pipe sheet piles in the bedrock under water.

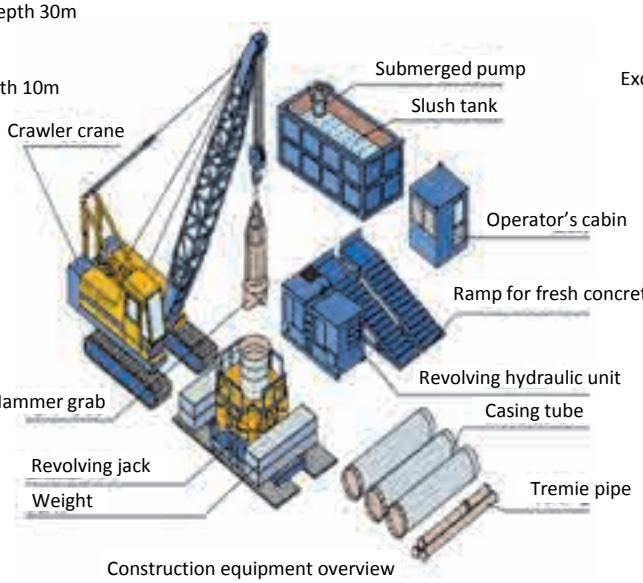
【Background of selection of the work method】

・Relatively economical for the excavation of 2m-dia. and max. 30m-deep holes in submerged bedrock.

・Has an operational record.

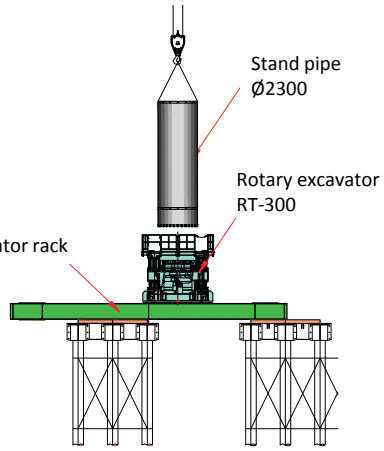
・Applicable to a wide range of bedrocks.

Excavation scale:
Width 10m x length 45m x maximum depth 30m
Excavation volume: 4,900m^3
Excavation shape:
Width 11m x length 11m x average depth 10m



Construction equipment overview

Construction site view with rotary excavator RT-300



【Characteristics】

・This method can apply to a wide range of soils and also allows for greater construction depth and excavation diameter than other methods. (Excavation depth: about 50m; excavation diameter: 3,000mm)

・The method supports most soil conditions.

・Clayey soil deposits on the outer periphery of the casing could increase a friction resistance, possibly hampering or preventing the revolving of the casing.

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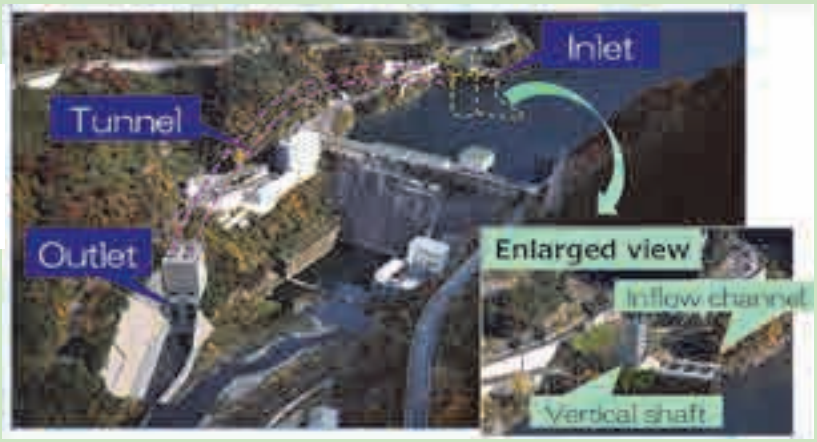
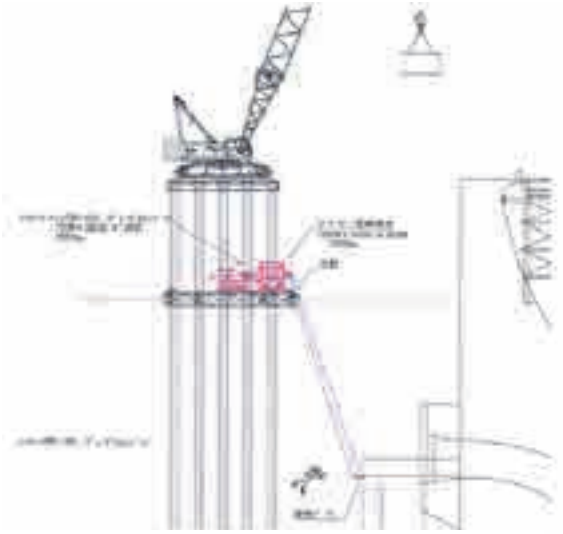


Source: Ministry of Land, Infrastructure, Transport and Tourism, Shikoku Regional Development Bureau pamphlet

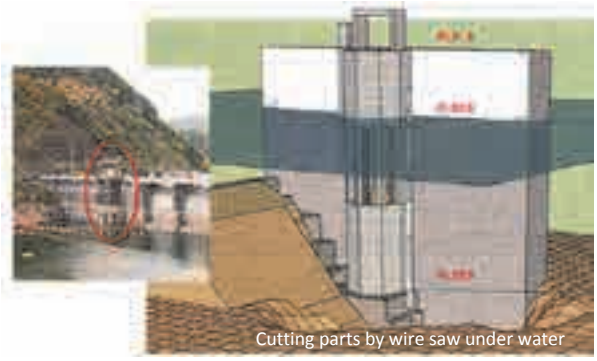
Underwater wire saw method

【Purpose】A part of underwater concrete structure was cut and removed by the wire saw, which was then placed above water level.
【Selection process of method】
Because of the lack of visibility in the reservoir (only 0～1m), the original method, that the main body was set underwater was changed to the alternative method that the main body was set on the barge above water level and extend wire into water , since it will be difficult to cope with incase of cutting the wire, and it has less ability of cutting, etc.
(Adopted wire saw：K-WAC-04、32.2Kw)
【Conditions】 Water depth：0～30m、Concrete strength：Approximately 30N/mm^2
【Features】
・Under water concrete structure was cut by wire saw and was placed above water level.
・It is possible to execute when that the reservoir has the lack of visibility and it is difficult to work underwater.
・Maintenance work is easy because the wire saw itself is placed above water level.
・It is not necessary for the wire saw to replace every place to cut off.
・Great depth result in the increasing the risk of cutting wire because the length of the wire saw is long.
・Since the method use crane, restraint time will be longer.



Cutting of the concrete structure undrewater by wire saw

【Procedure of the work】
(ⅰ) Set the wire saw body (cutting machine) on the barge and cut the concrete in the underwater block into blocks of 20 t or less.
(ⅱ) Cut the concrete block by lifting it with a crawler crane (120 t) placed on the temporary gantry.
(ⅲ) Dispose of the removed concrete lumps in large trucks after handling them to a predetermined location.



Cutting parts by wire saw under water

Cutting of the concrete structure

Lifting cut concrete mass in water

Summary of the project

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Height：61m、Crest length：167.9m、Volume：161,000m^3
【Purpose】
Flood control、hydropower

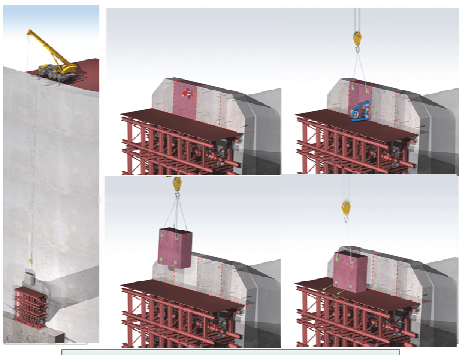
【Purpose of the project】
A tunnel flood discharge is newly constructed on the right bank of the dam, with the aim of setting the flood control capacity of the existing Kanogawa dam 1.4 times.
A tunnel flood discharge:
Standard inside diameter 11.5m, Maximum excavate section 320m^2

In the Kano River dam remodeling project, new low water discharge facility "and "selective water intake facility" are constructed for the purpose of preventing cold water discharge and prolongation of turbid water discharge and suppressing eutrophication of reservoir.

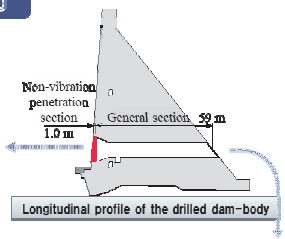
Image of the project
"Reprinted from the pamphlet of Yamasakizaka Dam Construction Office, Shikoku Regional Development Bureau, Ministry of Land, Infrastructure and Transport"

Drilling the existing dam body using road header

Dam-body Drilling



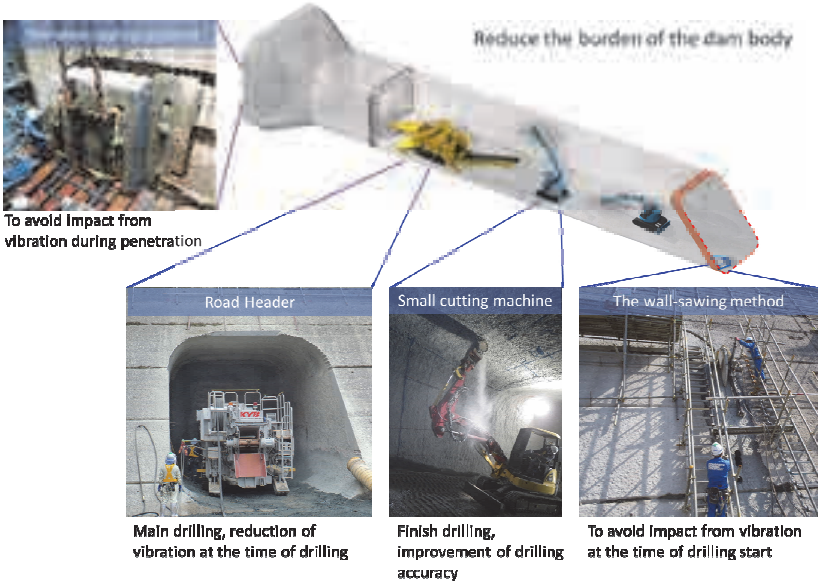
Overview of the non-vibration penetration technique



Longitudinal profile of the drilled dam-body

Drilling the dam-body

In the existing dam, a total five holes were drilled: three for the expansion of discharge pipes and two to move the power generation intake pipes.
To drill five locations in the same dam-body is the largest scale in Japan, as a dam upgrading work.
The drilling depth per hole is approx. 60 m, which contains a section of 1 m of upstream non-vibration penetration section (hole size: vertical 6 m, horizontal 6 m).
To drill the general section, a 200 to 240 kW class road header was used.
The vibration value on the dam-body was mesured to confirm if there are any effects on the dam-body.
This picture shows the drilling work performed by a road header.
As it was reported from similar construction that vibration would be the strongest at the time of penetration, the non-vibration penetration technique was adopted to avoid impact from vibration during penetration.



To avoid impact from vibration during penetration

Main drilling, reduction of vibration at the time of drilling

Finish drilling, improvement of drilling accuracy

To avoid impact from vibration at the time of drilling start

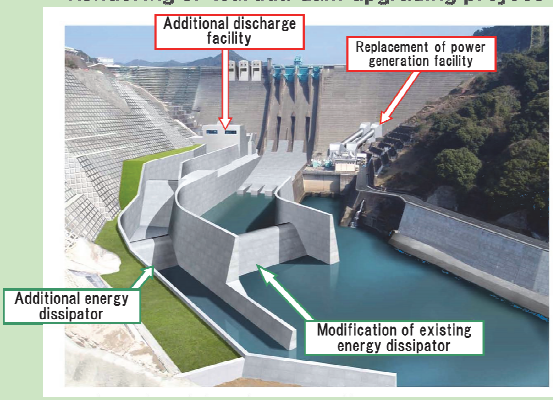
Summary of the project

【Dam Specifications】
Type：Concrete gravity dam
Height：117.5m
Length：450.0m
Volume：1,119,000m³
purpose：flood control and power generation

The concept of the project is to increase flood capacity and discharge facilities.
The increase in flood storage will increase to a total capacity of between 75 million m³ and 98 million m³ by transferring the power generation capacity during flood season of 2.5 million m³ and dead water storage of 20.5 million m³, for a total of 23 million m³, to flood storage.The discharge facility was expanded to enhance discharge capacity by adding three conduit gates on the right dam-body (EL 115.6) at a location lower than the current discharge facility (EL 130.0) in accordance with the decline of the lowest water level.

Overview of the Redevelopment

Rendering of Tsuruda dam upgrading project

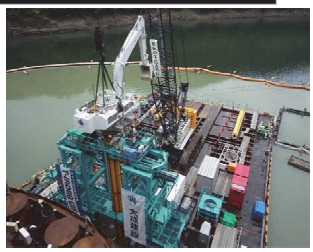


Underwater Work Method by Shaft-Style Equipment

Remote Controlled Multifunctional Underwater Equipment
Underwater Operation Using an Equipment with Apprratures

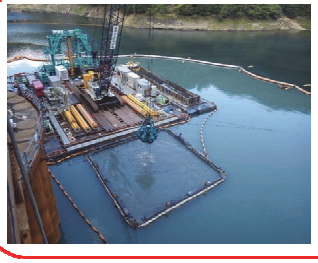
①Erection of Shaft

②Instllation of Equipment, Launch



③Rock crushing, Debris collecting

④Dredging



Summary

This equipment enables a series of underwater operations such as rock crushing, excavation, debris, disposal, precise sounding, photography, etc. in a safe and reliable condition through remote controlling. These are carried out by using various apparatus on a machine attached to a shaft which is lowered from a barge. The machine moves up and down along the shaft.

The equipment has been developed to conduct various underwater works without divers. It is especially advantageous for works in deep, steep and limited visibility areas such as dam reservoirs. Significant improvements of safety and operational efficiency are observed through remote controlled visualization technology and computerized technology.

Specific Features

a. Enables deep underwater (-50m) works without divers
b. Applicable for all types of reservoirs
c. Applicable for very steep areas via an equipped casing auger
d. Applicable for deep and dark reservoir bases via equipped ultrasonic camera
e. Enables precise execution via equipped sounders

Various Apparatuses

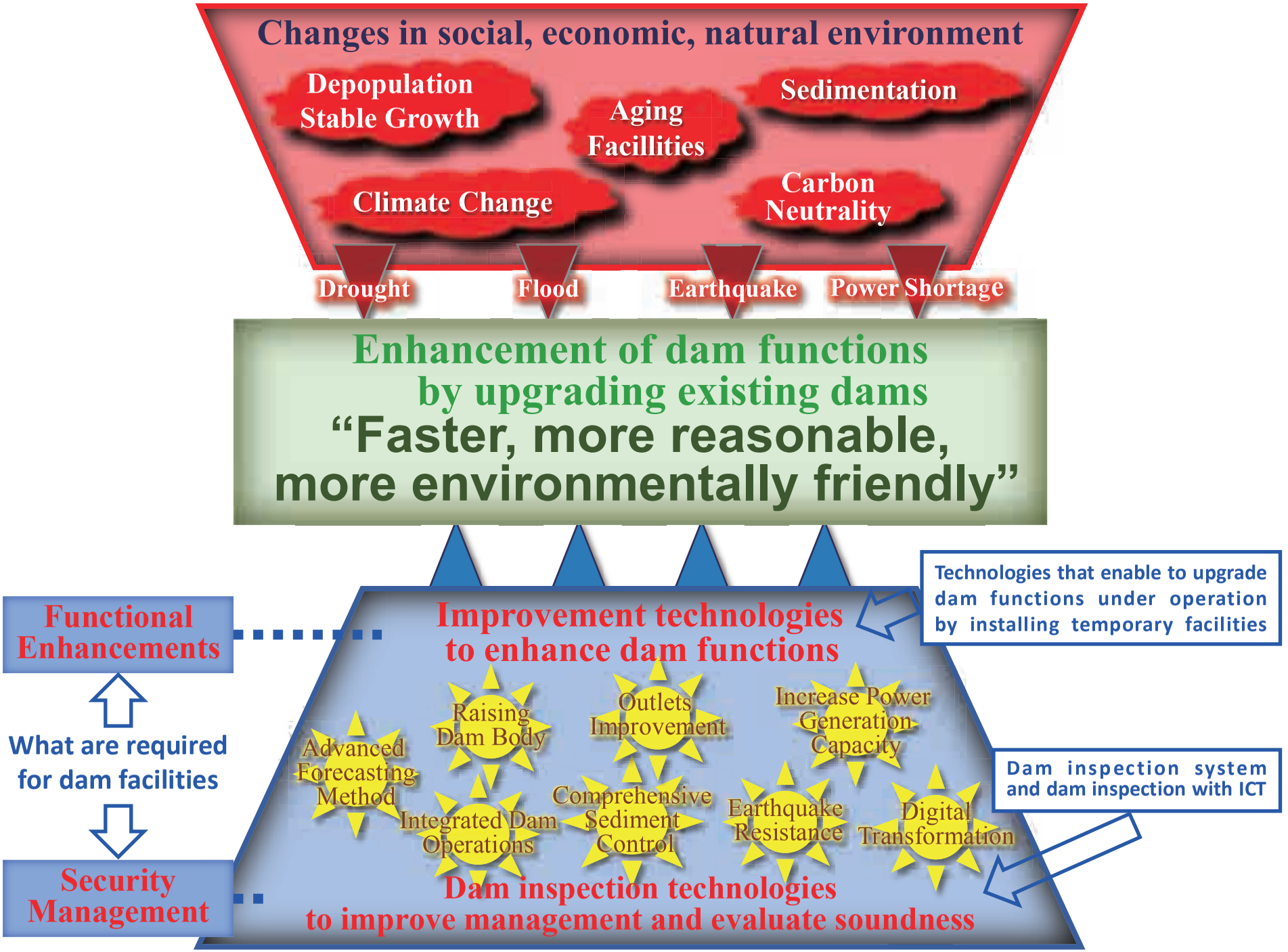
Summary of the project

This method was adopted for the construction of the inflow and vestibule area of the tunnel discharge facility in the **Amagase Dam Redevelopment Project**.

Amagase Dam Specifications

Model: Arched concrete dam
Dam height: 73.0m
Crest length: 254.0m
Dam volume: 122,000m^3
Total reservoir capacity: 26,280,000m^3
Effective reservoir capacity: 20,000,000m^3
Purpose : Flood control, Waterworks, Power generation

Inspection for Dam Safety


Changes in social, economic, natural environment
Depopulation
Stable Growth
Aging
Facillities
Sedimentation
Climate Change
Carbon
Neutrality
Drought
Flood
Earthquake
Power Shortage
Enhancement of dam functions
by upgrading existing dams
“Faster, more reasonable,
more environmentally friendly”
Functional
Enhancements
What are required
for dam facilities
Security
Management
Improvement technologies
to enhance dam functions
Technologies that enable to upgrade dam functions under operation by installing temporary facilities
Raising
Dam Body
Outlets
Improvement
Increase Power
Generation
Capacity
Advanced
Forecasting
Method
Integrated Dam
Operations
Comprehensive
Sediment
Control
Earthquake
Resistance
Digital
Transformation
Dam inspection system
and dam inspection with ICT
Dam inspection technologies
to improve management and evaluate soundness

Do you inspect dams at the right time?

Regularly | Age-related deterioration | After a flood | After an earthquake

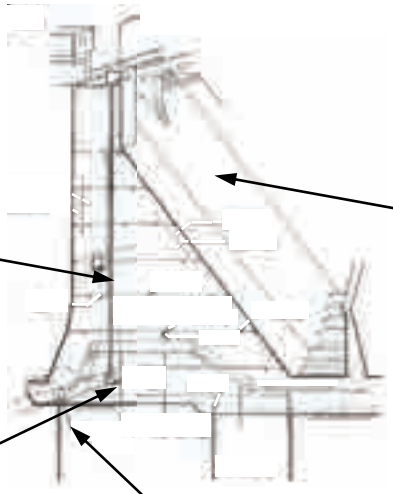
Do you inspect dams in adequate ways?

Deformation

Normal plumb line

Visual Inspection

Appearance inspection



Uplift

Bourdon pressure gauge

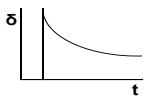
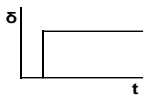
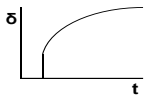
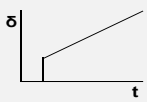
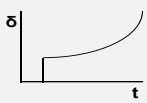
Are there clogs like this?

Leakage

Drain hole

Triangular weir

How have the accumulated measured values changed over time?

Change over time		Evaluation	Measurements and Countermeasures
	Under a constant load condition, the measured values have been decreasing.	Safe (Stable & Sound)	Usual measurements
	Under a constant load condition, the measured values have remained constant.		
	Under a constant load condition, the measured values have been increasing, but the rate of the increases have been decreasing.		
	Under a constant load condition, the measured values have been increasing at a constant rate.	Hazardous	Carrying out careful measurements Examination of countermeasures
	Under a constant load condition, the measured values have been increasing with an accelerating increase.	Dangerous	Implementation of countermeasures Emergency countermeasures : Drawdown Permanent countermeasures Partial abnormality : Repair works Widespread abnormality : Improvement works, etc.

Examples of dam inspections by ICT

Regularly | Age-related deterioration | After a flood | After an earthquake

Example of displacement inspection and measurement by GNSS at fill dams

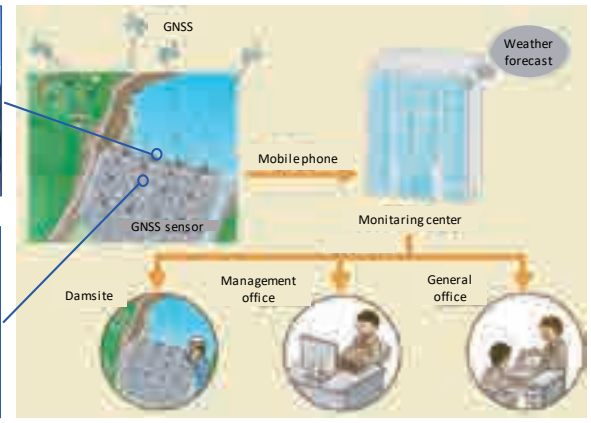
Visual inspection
(Once a day ～ Once a week)
Measurement
(Once every 3 months)

⇨

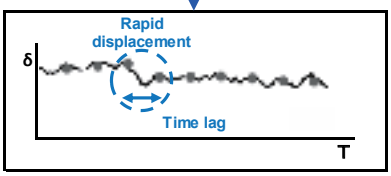
Continuous, high-accuracy measurement by GNSS

⇨

Anytime, anywhere
Can be checked with a mobile phone
Early detection
Deformation after sudden changes in water level
Deformation after an earthquaqe

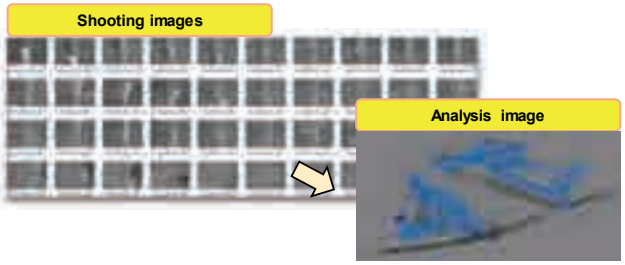


Periodic measurements cannot capture the rapid displacement immediately after an earthquake

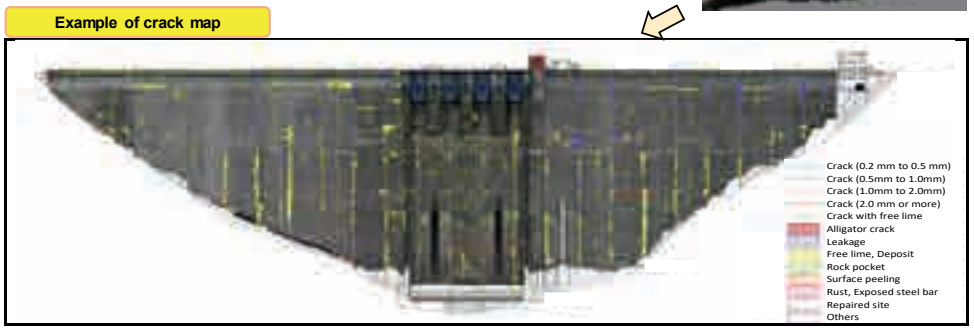


● : Electro-optical distance measuring
— : GNSS

Example of drone inspection of concrete dams



Inspection without drone



Conventional visual inspection

⇨

Visual inspection by drone

⇨

Digital data management for the entire dam through the use of ICT
Anywhere
Drones can take photos even any areas where people is not accessible
Early detection
Abnormalities immediately after an earthquake
Even small cracks, leaks, etc.

Abbreviation
GNSS : Global Navigation Satellite System
ICT : Information and Communication Technology

Dam Advisory Experts from JAPAN

Why Dam Safety Inspection Matters

- ✓ Inspection can keep your dams active
- ✓ Inspection can develop your engineers' capacity
- ✓ Inspection can revive your business longer

Inspection Items

Category	Inspection Items
Operation and Maintenance	(i) Arrangement of personnel
	(ii) Dam management system
	(iii) Reservoir management system
	(iv) River flow condition
Dam equipment and reservoir	(i) Dam body and its foundation
	(ii) Mechanical equipment
	(iii) Electrical equipment
	(iv) Reservoir

Dam Safety Inspection in Japan

[Dam Inspector] [Dam Manager]

Report inspection

[Dam Inspector] [Dam Manager]

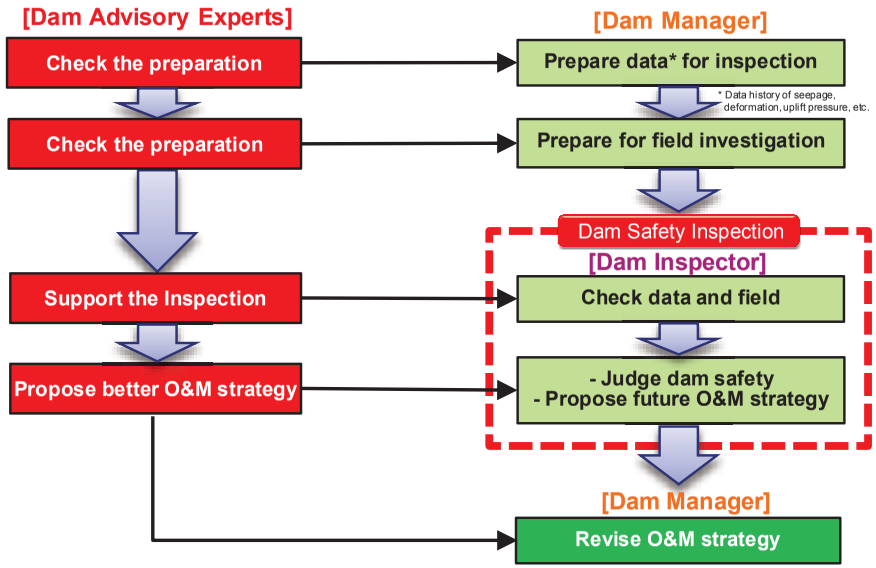
Operational panel inspection

Daily reservoir operation

Mechanical Validation

How Dam Advisory Experts Works

[Dam Manager] Your organization/authority/company
[Dam Inspector] Your organization/authority/company
[Dam Advisory Experts] from JAPAN



Leave the Water Management to Us!

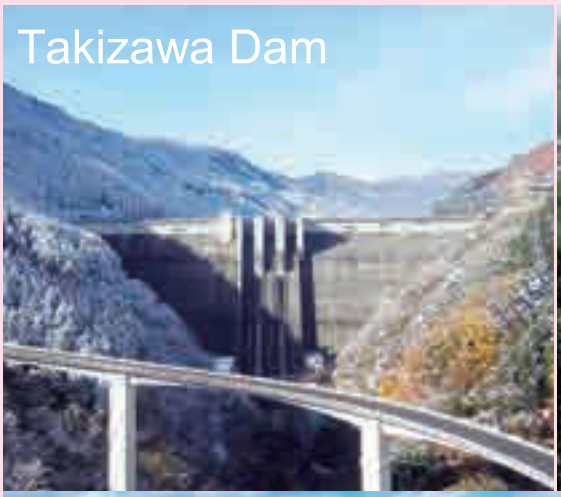
JWA Supplies you with Safe and Quality Water

JWA supplies safe and good-quality water to meet the demand of people in Japan.
To ensure stable supply of such water, JWA works around the clock, 365 days a year, to operate and maintain its water supply facilities, including dams and canals.

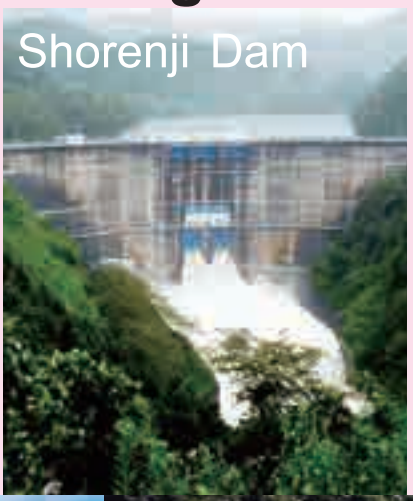
Japan Water Agency (JWA)

43 Dams and about 1,000km of canals were constructed by JWA. These facilities supply domestic water, agricultural water and industrial water to the 65 million people in the designated water supply area in Japan.

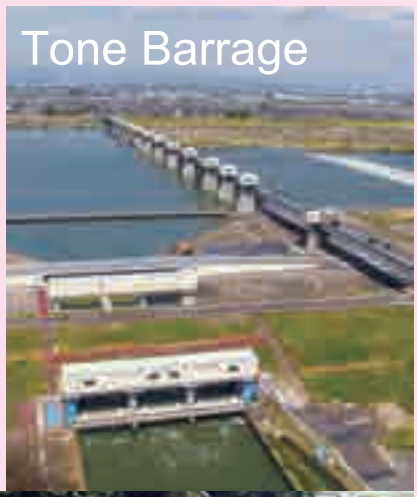
JWA's Dams, Barrages and Canals



Takizawa Dam



Shorenji Dam



Tone Barrage

Tokuyama Dam

Contact Us

Please send your inquiry, opinion, and/or comments on JWA to webmaster@water.go.jp.

Toyogawa Canal

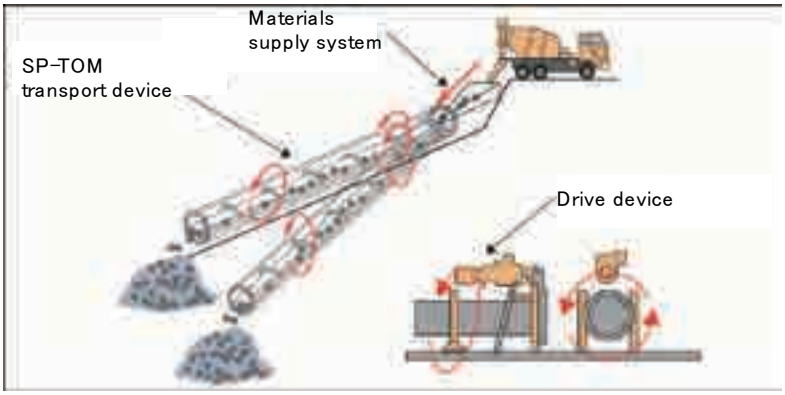
Appendix

We have Original Advanced Technologies

New Construction Technologies

SP-TOM (Special Pipe Transportation Method)

This method can transport large quantities of concrete, soil and stone stably and continuously, by rotating a steel-pipe which several hard rubber blades are installed in a spiral pattern inside. The pipeline is installed on the slope.



SP mixer (Special Pipe mixer)

This mixer was developed to mix CSG materials. This method is to mix materials passing through the interior by rotating a mixing tube equipped with blades inside the mixer.

The mixing tube is installed to incline. The self-weight of the CSG materials cause them to flow through the mixer. This mixer has two mixing effects inside its mixing tube; forced agitation by drive power and falling.

Patent:
Incorporated Administrative Agency Japan Water Agency; KAJIMA CORPORATION; OBAYASHI CORPORATION; TOBISHIMA COPORATION; Kumagai Gumi Co., Ltd.; The Zenitaka Corporation; Osakasaiseki Engineering Corporation

KAJIMA CORPORATION	
Contact Person:	Construction Management Dept. Hitoshi Numoto
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Phone:	+81-3-5544-1111
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Floating Type Upstream Cofferdam Method

Innovative Dam Redevelopment – A New Coffering System for Underwater Work–

Feature of technology

With the floating type upstream cofferdam method, steel plates (skin plates) are attached to both the inside and outside of the bulkhead, the upstream cofferdam barrier that is integrated into the base is floated, and is supported by installing an anti-buoyancy brace on the top barrier of the dam body. The construction assembles barrier blocks made at the site on the reservoir surface, tows them to the installation position, pulls them by winch and secures them. The floating type upstream cofferdam method--assembling and installing while adjusting the ballast by filling and draining water from a reservoir--is the first of its kind in the world.

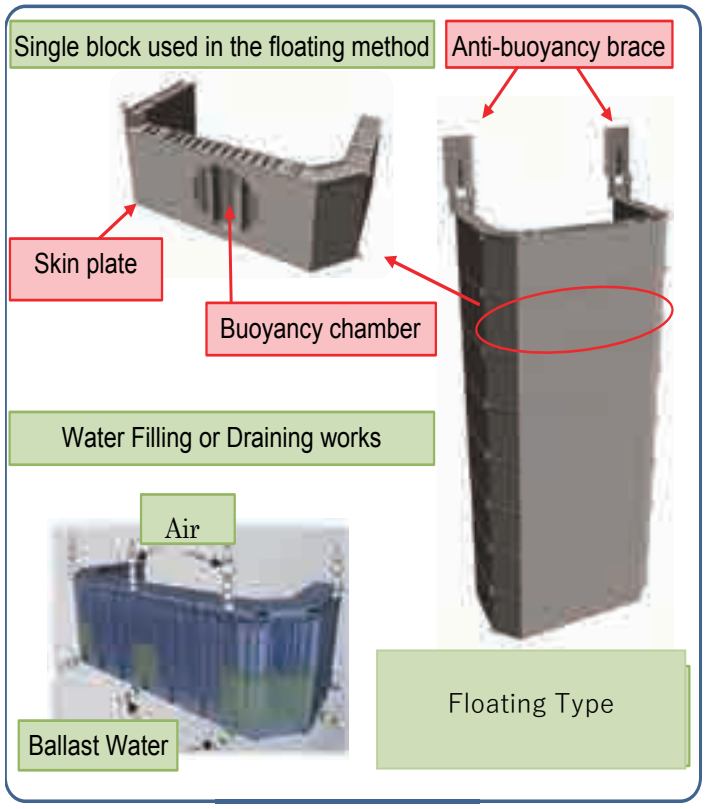

Figure of Structure

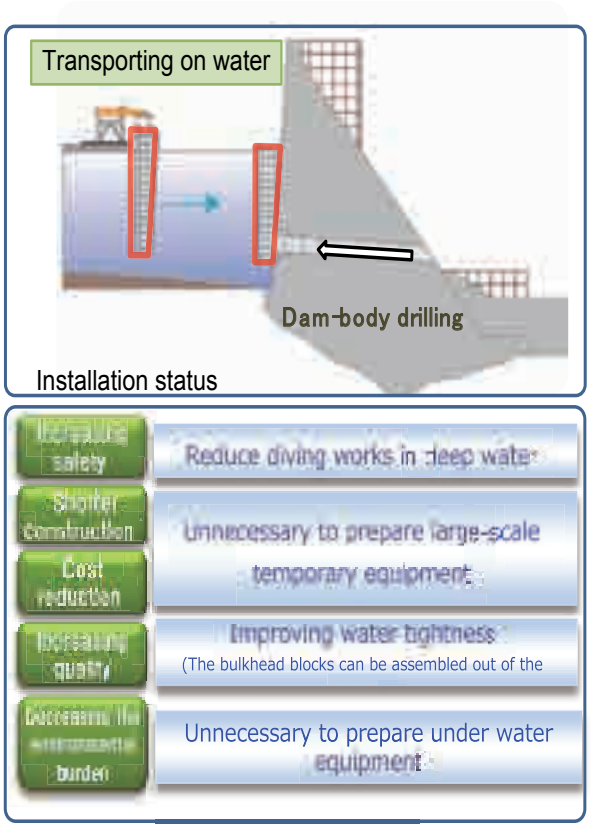

Figure of Structure

Technology developers:
Kajima Corporation; Hitachi Zosen Corporation
Joint developers:
Ministry of Land, Infrastructure, Transport and Tourism Kyushu Regional Bureau; Japan Dam Engineering Center

KAJIMA CORPORATION	
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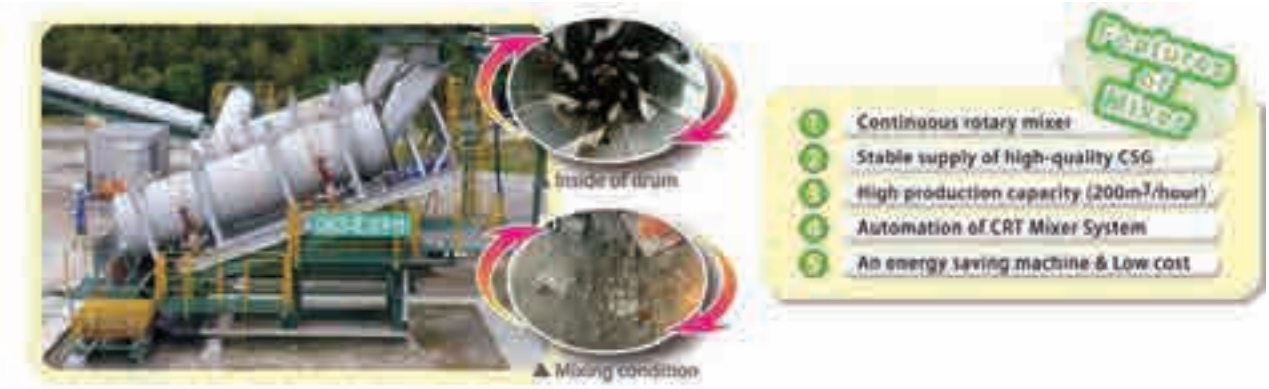
URL:	https://www.kajima.co.jp/english/welcome.html

CRT(The Continuous Rotary Tube)Mixer System

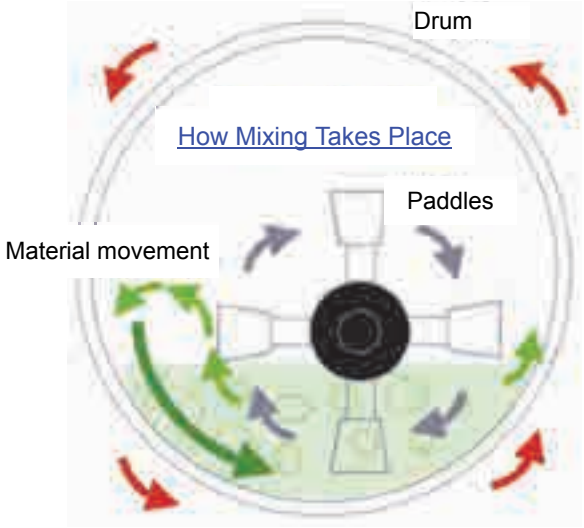
The Continuous Rotary Tube (CRT) Mixer System provides using the Cemented Sand and Gravel (CSG) Method. By attaching agitating blades inside the steel drum and maintaining specified rotation speeds and angles, the mixer is capable of producing mixtures of consistent and stable quality.



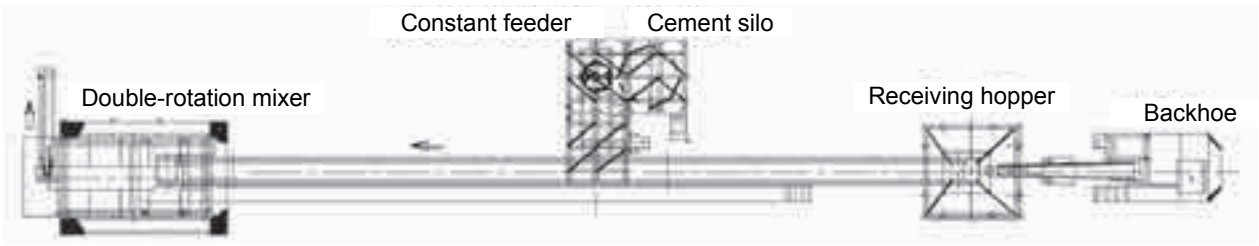
Nishimatsu Construction Co.,Ltd.	
Contact Person:	Public Relations Department
E-mail:	kouhoubu@nishimatsu.co.jp
Phone:	+81-3-3502-7601
URL:	https://www.nishimatsu.co.jp/eng/

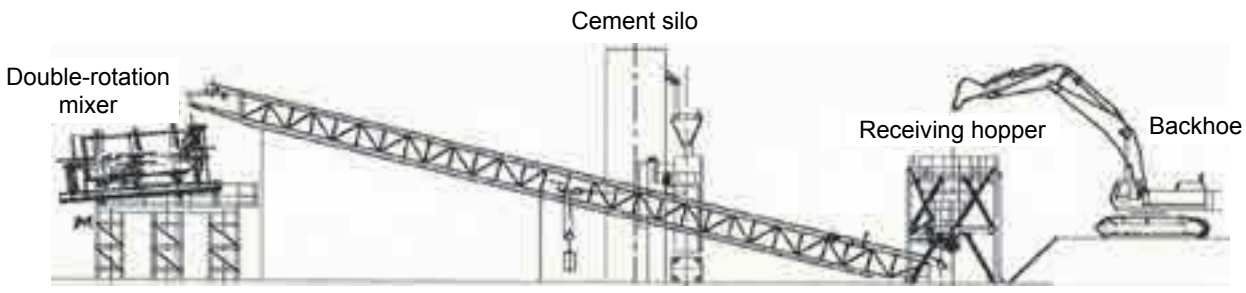
Newly Developed High-performance CSG Mixer: Double Rotation Continuous Mixer

The newly developed double-rotation mixer combining the characteristics of a tilting mixer and a forced circulating mixer produces high-quality CSG (Cemented Sand and Gravel) mixes at a rate exceeding 200 m^3/h



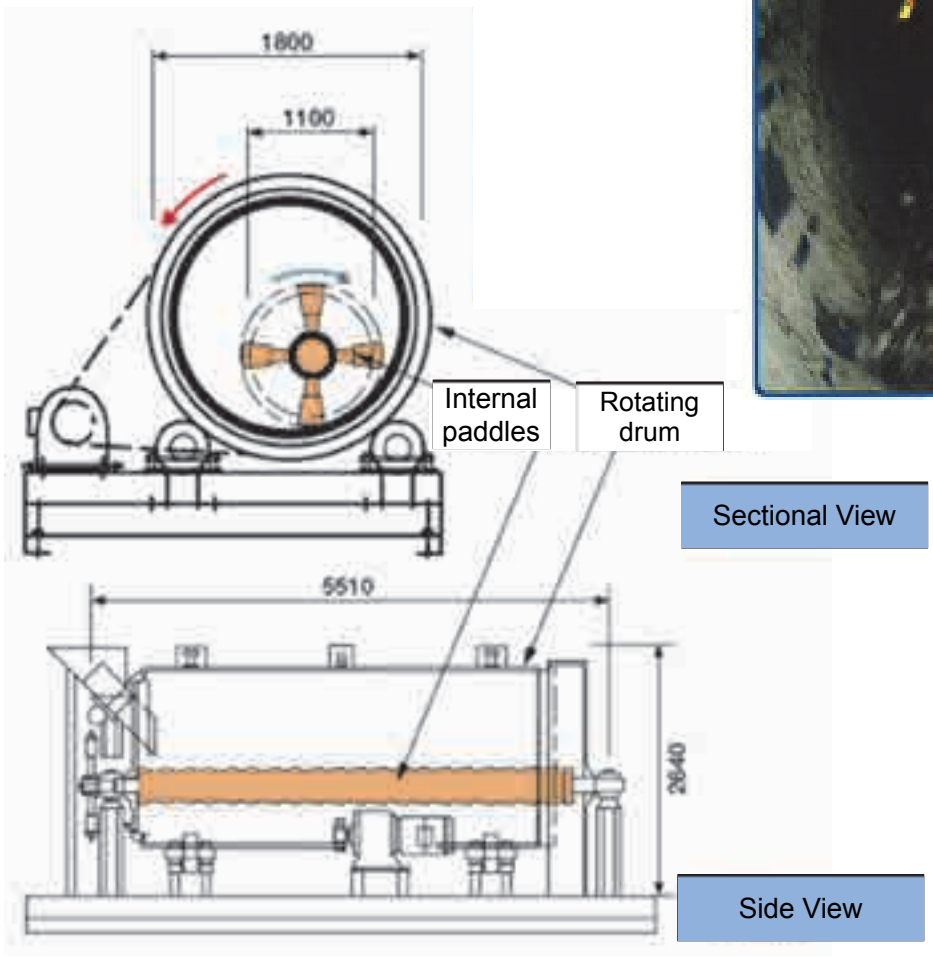
Example of Concrete Plant Layout





Mixer Specifications

Rotating Drum Specifications		
Drum inside diameter and height		φ1800×4200L
Rotation speed and direction		10 rpm (clockwise looking in the direction of movement)
Motive power		37kw×220V
Drive system		Chain drive
Support system		Roller (φ400 × 145L) × 4
		Thrust roller (φ250 × 90L) × 2
Inner Paddle Specifications		
Mixer outside diameter, pitch and number of paddle shafts		φ1100 × P1000 (two shafts)
Rotation speed and direction		38 rpm (counterclockwise looking in the direction of movement)
Motive power		45kw×220V
Drive system		Chain coupling drive, chain drive
Support system		Bearing
		Plummer block (φ135)
Paddle inserts	Size	30t-220-220
	Quantity	36 pcs.



Mixing

SHIMZ CORPORATION	
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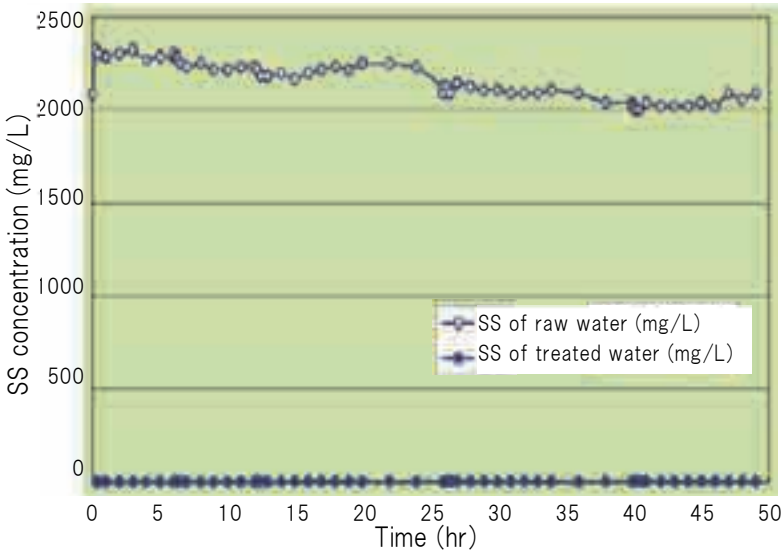
New Water Filtration System (Advanced Membrane Filtration Process)

In construction projects such as tunnel and dam construction and site preparation, proper treatment of turbid water generated from construction work is important in order to protect the environment. There has also been growing demand for higher water treatment performance than required by the current standards of the local governments.
Conventional turbid-water treatment processes relied mainly on coagulation and sedimentation. Shimizu's newly developed filtration system effectively removes suspended solids by use of a membrane filtration process to achieve higher water quality in an environmentally considerate manner and provide solutions to current and emerging problems.

Features

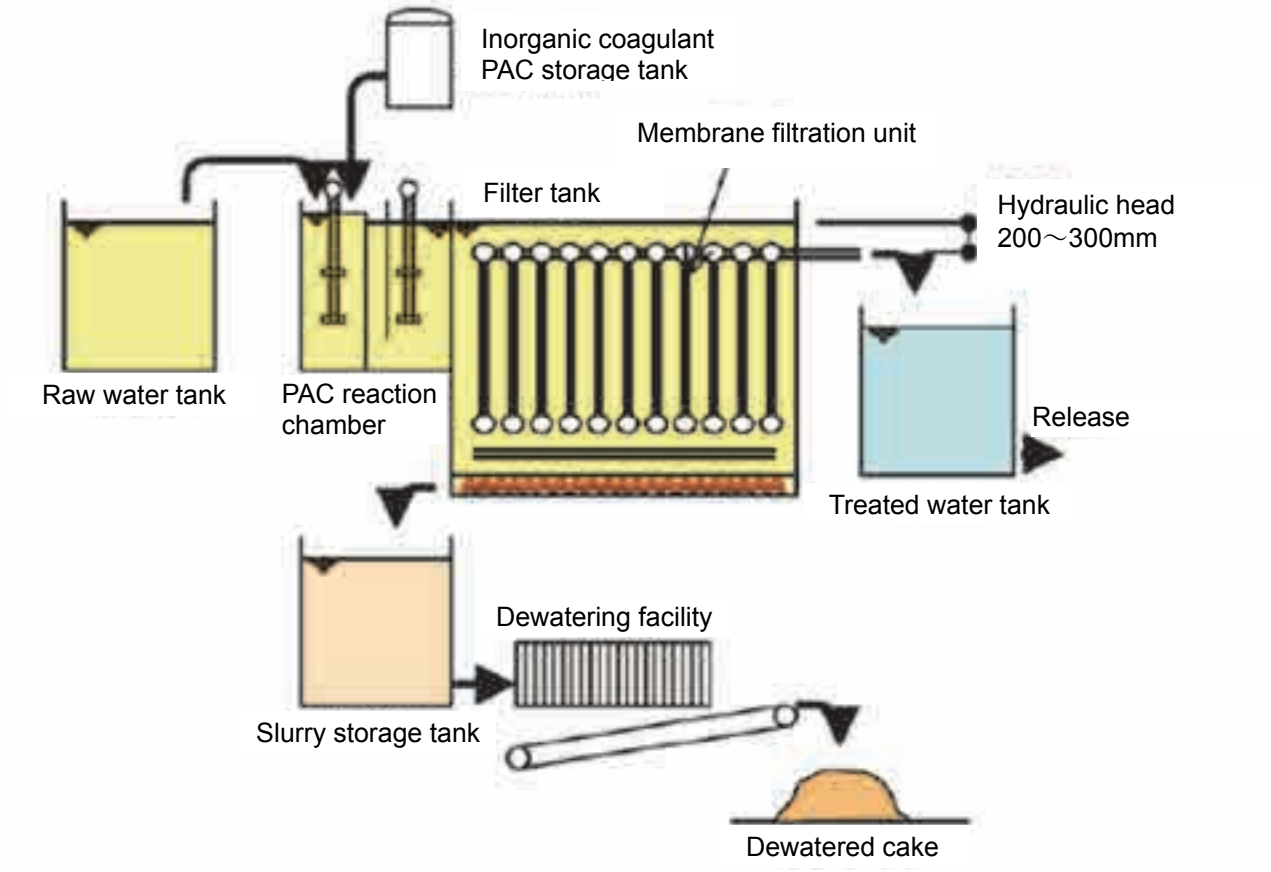
- The filtration process reduces the SS concentration of turbid water to 5 mg/L.
- High turbidity (SS1000–3000 mg/L) water can be treated directly.
- The process is environmentally friendly because it does not use any organic polymer coagulant.
- The system footprint is compact because sand filtration is not used.
- The water treatment system is environmentally considerate because it requires only a small amount of electricity.

Turbid Water Treatment Test Data

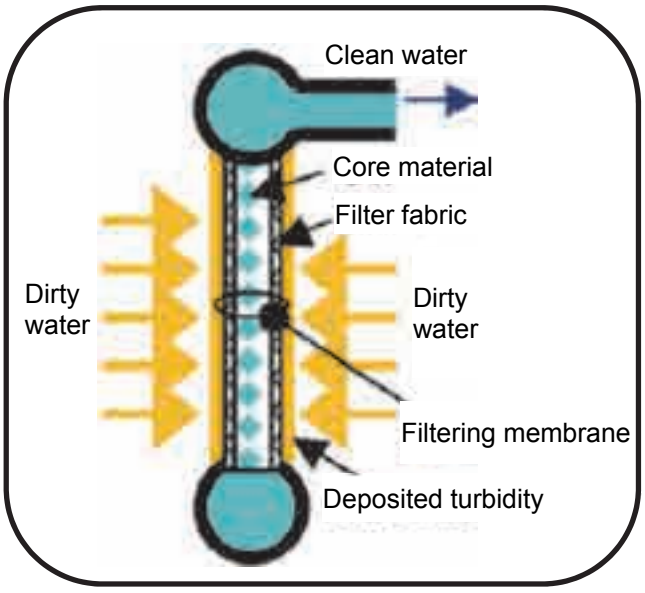


Raw water and treated water

System Flow



How Membrane Filtration Works



Membrane Filtration Capacity

Let A (m2) represent the area of the membrane surface. Then, membrane filtration capacity V (m3/day) can be calculated as follows:
V = A × 2 m3/day

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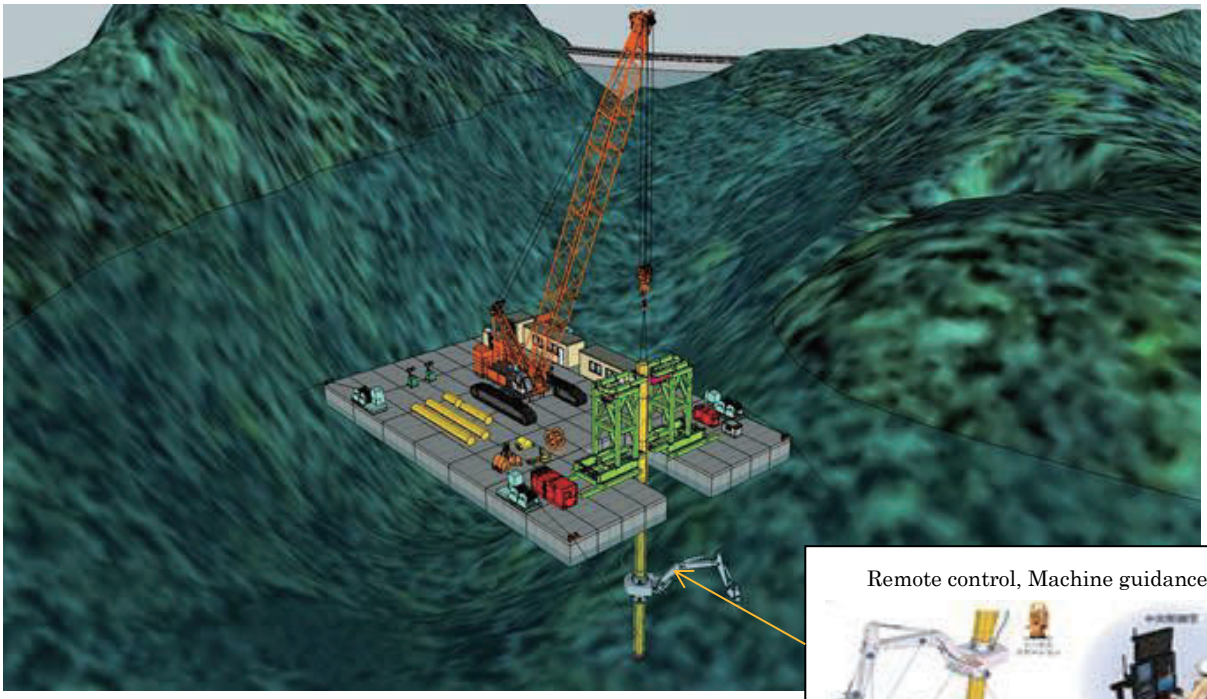
URL:	https://www.shimz.co.jp/en/

Remote Controlled Multifunctional Underwater Equipment

Underwater Operation Using an Equipment with Apparatus (T-iROBO UW)



Summary

This equipment enables a series of underwater operations such as rock crushing, excavation, debris disposal, precise sounding, photography, etc.in a safe and reliable condition through remote controlling. These are carried out by various apparatuses on a machine attached to a shaft which is lowered from a barge. The machine moves up and down along the shaft.

The equipment has been developed to conduct various underwater works without divers. It is especially advantageous for works in deep, steep and limited visibility areas such as dam reservoirs. Significant improvements of safety and operational efficiency are observed through remote controlled visualization technology and computerized technology.

Specific Features

a. Enables deep underwater works without divers
b. Applicable for all types of reservoirs
c. Applicable for very steep areas via an equipped casing auger
d. Enables a series of works to be carried out by various apparatuses
e. Equipped with I.T, machine guidance
f. Applicable for deep and dark reservoir bases via equipped ultrasonic camera
g. Enables precise execution via equipped sounders

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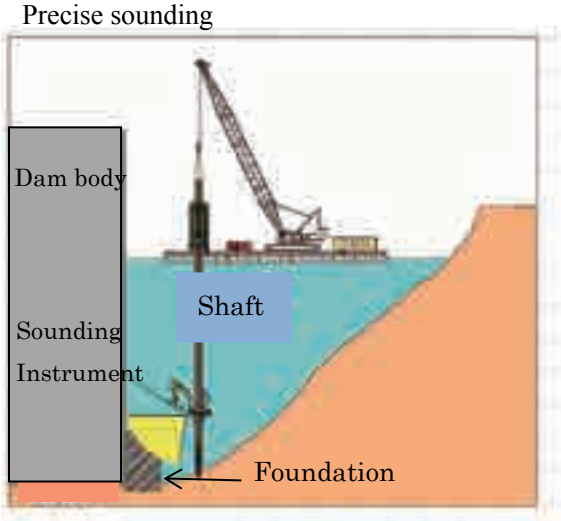
Various Apparatuses

Applicable for a series of works via various apparatuses attached to a machine

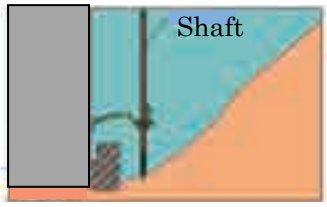
Rock crushing with a breaker　　Sand pump suctioning　　Cleaning by an ejector

Examples of applicable works

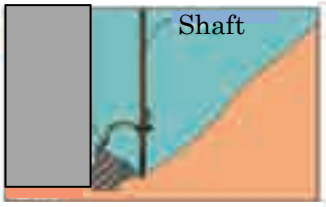
Precise sounding



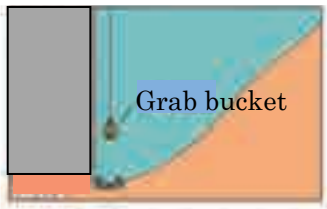
Edge cutting



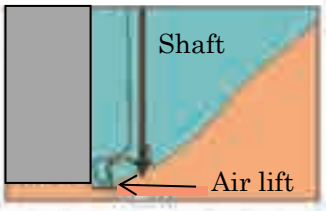
Crushing concrete



Grab dredging



Surface treatment



Other applications

a. Drilling by an air drifter

b. Surface cleaning by a rotary brush

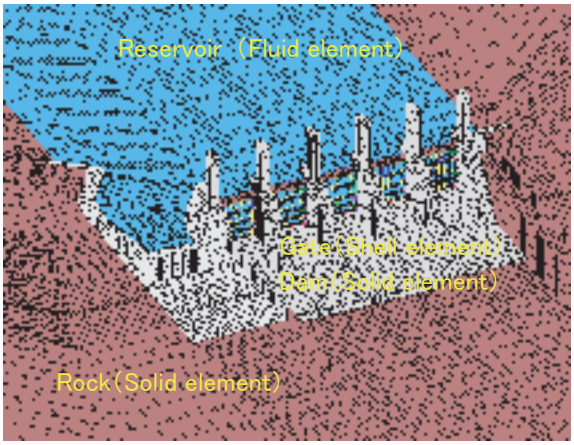
c. Rock & concrete cutting by wire-saw

d. Steel beam & pipe and reinforced concrete cutting by nibbler

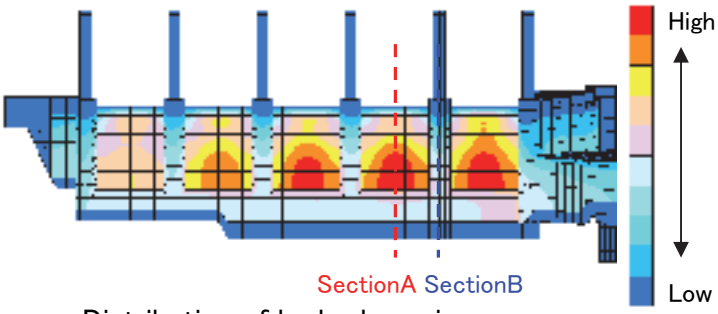
Hydrodynamic Pressure on the Gate

The hydrodynamic pressure acting on the Gate is larger than which acting on the Dam body (Westergaard's formula)

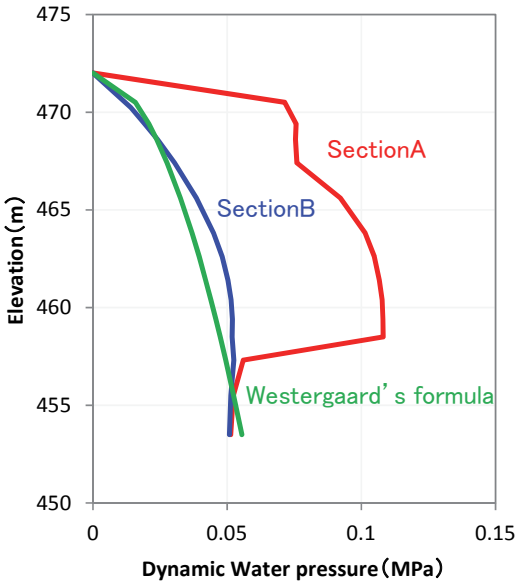
①Entire System Analysis Model (Dam-Gate-Rock-Reservoir)



Analytical model: Dam-Gate-Rock-Reservoir Model
Analysis approach: 3-Dimensional Linear Dynamic Analysis
Number of nodes and elements: About 250,000

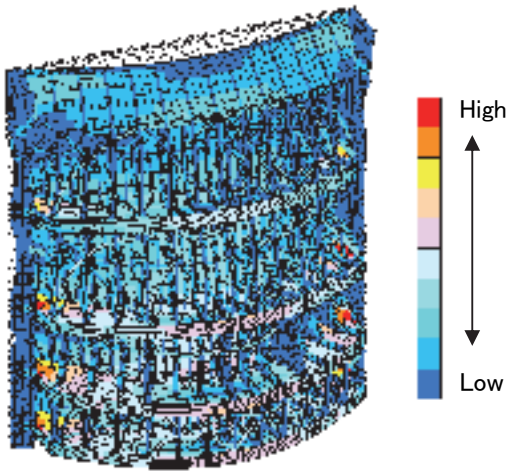


Distribution of hydrodynamic pressure



②Gate Analysis Model

Analytical model: Gate Model
Analysis approach: 3-Dimensional Linear Dynamic Analysis
Number of nodes and elements: About 20,000



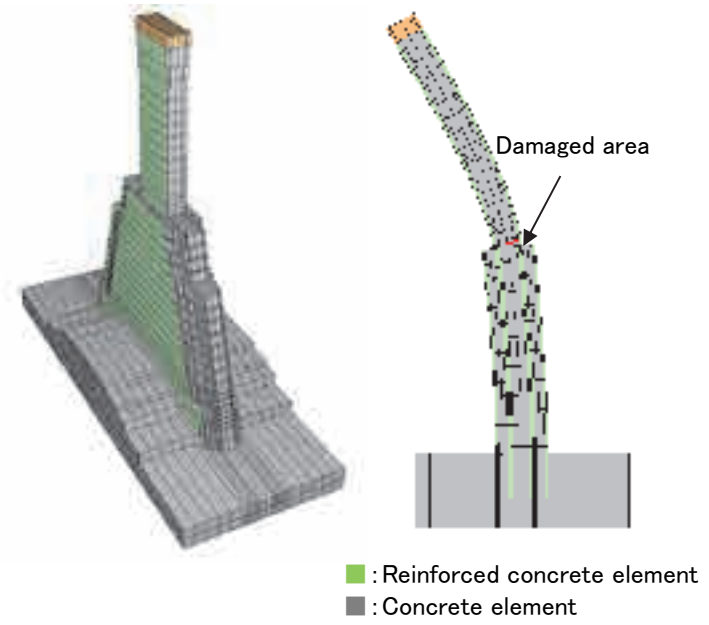
Distribution of stress and displacement

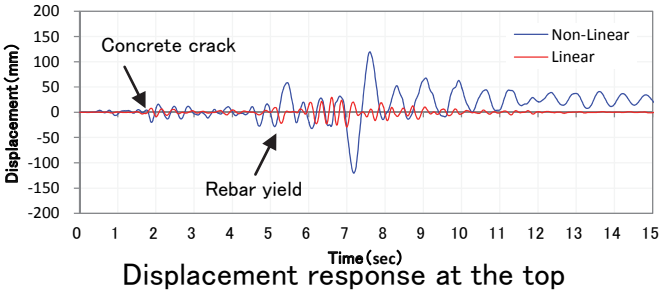
- The hydrodynamic pressure acting on the Gate is derived from the entire system analysis model.
- High reliable value of the stress on the Gate is calculated by Detail Gate Analysis Model.

The Non-linear Analysis of Pier

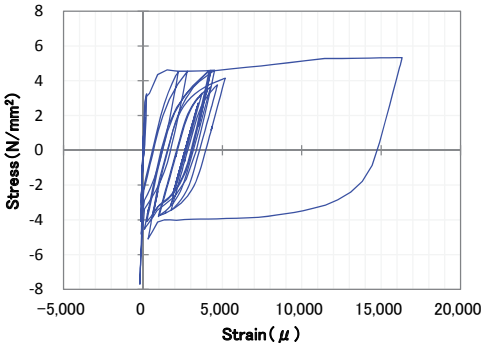
Plastic deformation is visualized

①Before aseismic reinforcing work



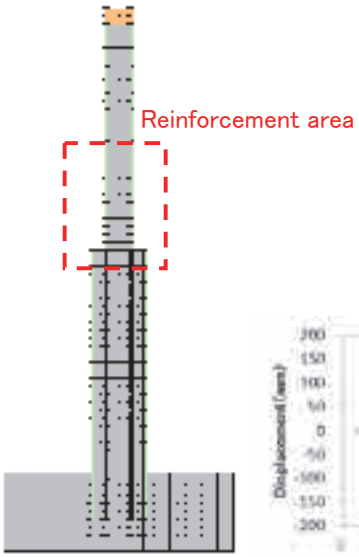


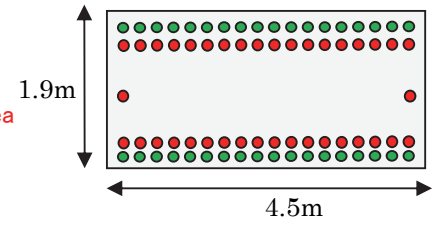
Displacement response at the top

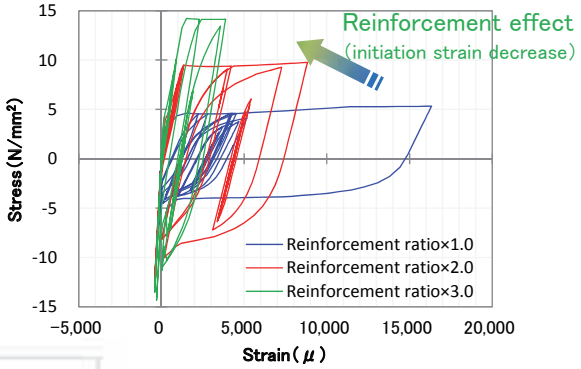


Stress-Strain relation

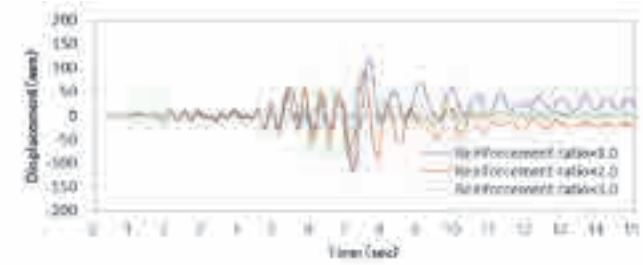
②After aseismic reinforcing work







Stress-Strain relation



Displacement response at the top

- Physical behavior of the pier concrete after cracking is derived and visualize
- Structural residual deformation on the pier after the earthquake is derived and visualize

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Dredging method using amphibious bulldozer Model D155W

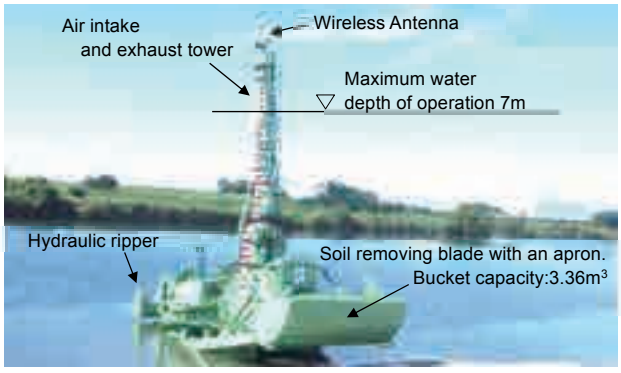
Since their first appearance as the construction equipment for marine excavation works in 1971, the amphibious bulldozers have been engaged in over 1200 projects throughout Japan, taking full advantage of accumulated knowledge and experiences for over 50 years.

Technical characteristics

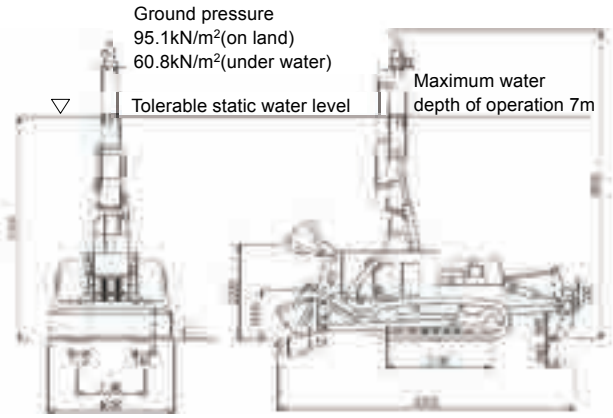
Amphibious bulldozers are radio remote-controlled construction machines that demonstrate their power in shallow water areas.

The dredger can dredge in areas where the water is too shallow to navigate or at depths of 0 to 7 meters where it is impossible to construct with land-based machinery.

This machine mainly performs dredging of underwater areas. Equipped with a bucket (3.36m^3) in front of a large earth removal plate, it excavates underwater without letting the dredged soil escape. Dredged material is transported underwater to shore. It is more accurate and economical than other dredging methods.



Radio remote-controlled amphibious bulldozer 43.5 t class



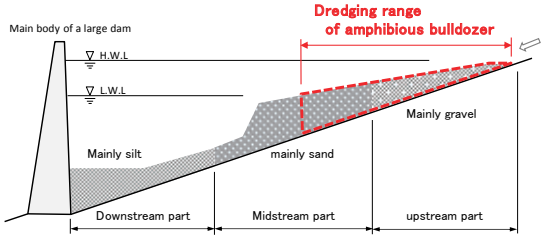
Outline drawing of amphibious bulldozer Komatsu D155W

Specific features

- The operator's safety is ensured as the machine is remotely controlled using wireless control.
- In the event of a sudden rise in water level, this machine can be quickly moved to a safe location for evacuating.
- Temporary construction work is minimal and cost-effective.
- Capable of dredging in areas with high flow velocity up to about 2 m/sec, where work vessels cannot be operated.

Applicability of amphibious bulldozers in dam reservoir

The middle to upper reaches of the dam reservoir have relatively high flow velocities and shallow water depths. The gravel and sand sediments formed in this area can be removed by dredging with an amphibious bulldozer.



Dredging range of amphibious bulldozer in a dam reservoir

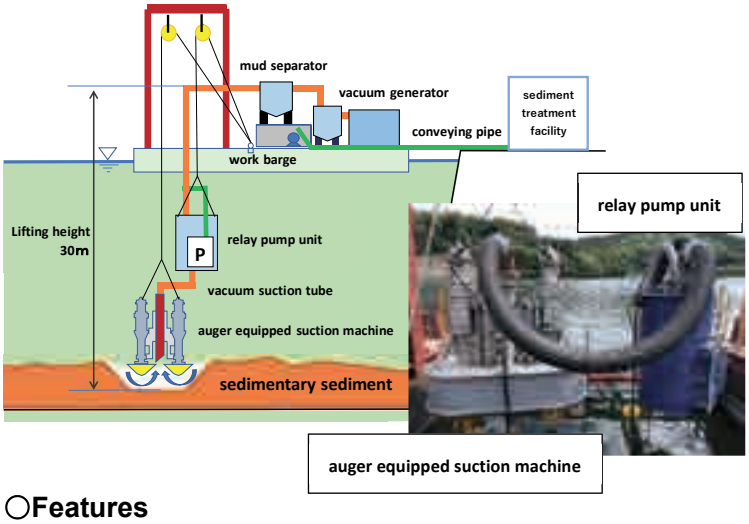
Dredging situation at dam reservoir

Asunaro Aoki Construction Co.,Ltd.	
Contact Division :	Civil Engineering Technology Division
E-mail:	tech-info@aaconst.co.jp
URL:	https://www.aaconst.co.jp/

Title **High-lift dredging method that** does not cause turbidity in water **"High-lift non-turbidity dredging method"**

○Abstract

We have developed a dredging method that can remove sediment from dammed lakes with a depth of 20 m or more and a lifting height of 10 m or more without causing water pollution. The method uses a combination of a powerful vacuum generator and a high-concentration stirring pump to achieve continuous sediment removal at a high lift without disturbing the lake bed. Due to the fact the new method does not cause turbidity in water , the dam can continue to generate power during dredging operations near the water intake. In addition, the new technique can be used throughout the year (including in flood season), which makes it far more flexible than existing methods.



○Features

1. It is possible to remove sediment with a lift of over 30m without polluting water quality, so the dam can continue to generate power, even when dredging occurs near the water intake.
2. Collective management is possible from an ICT central control room with just one operator.
3. In addition to enabling compact maintenance operations without the need for large-scale equipment, there is a degree of freedom in equipment organization that enables easy adaptation to local site conditions.

○Applications

・Where functional improvement and recovery of water intake facilities buried under sediment

・When the turbidity level of the reservoir is unacceptable

・In environments where it is difficult to lower the water level for maintenance

・When it is necessary to continue using water for power generation, agricultural use, etc. whilst removing sediment.

Fujita Corporation	
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Title「Underwater Inspection and other underwater tasks made possible by ROV」

Underwater Inspection Robot “DIAG”

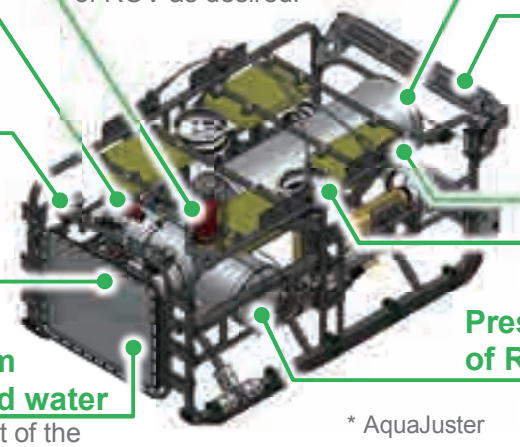
● Merit

Elimination of underwater work

- Manual underwater inspection tasks currently carried out by divers can be eliminated by using a remotely operated vehicle (ROV).
- In dam body renewal work, underwater investigation, surveys and simple tasks can be carried out through land-based operation and monitoring.

● MLIT-certified technology

- Experimental technology (★★★) recommended under the MLIT Program for Development and Implementation of Next Generation Infrastructure Robot Technology
- MLIT New Technology Information System (NETIS) No. KTK-150011-A



Underwater sonar

Line laser
Irradiation range: about 3 m
Measures damages or defects such as cracks.

High-brightness LED light
Brightness 3,780 lm
100 m water resistance

Main camera
2.38 megapixels
10x zoom

Underwater imaging system capable of imaging in turbid water
Water-filled box filter placed in front of the main camera
Acquires clear images even in turbid water.

AquaJuster®
Obayashi Corporation's patented technology
Controls the underwater attitude of ROV as desired.

Cleaning device
Plastic brush Variable (multi-step) rotation speed
Removes foreign matter deposits from the area to be inspected.

Float

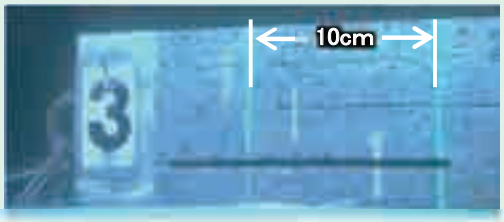
Thruster
DC brushless motor (200 W)
Two horizontal and two vertical units

Pressure-resistant container of ROV control system

* AquaJuster
A gyro-based mechanical attitude controller effective in an environment where flow velocity does not exceed one knot

Features

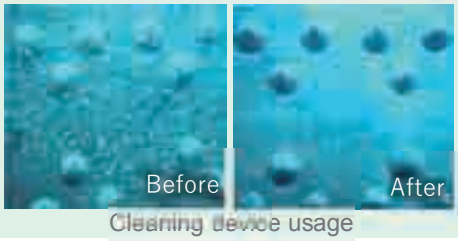
- The combined use of high-definition images and line laser (width: 100 mm) makes crack location and size measurement possible.
- Features such as the imaging system with a water-filled box filter and the image enhancer** make it possible to obtain clear underwater images.



High-definition imaging and line laser irradiation

Image enhancement device usage

** Image enhancer
A system that automatically recognizes adverse conditions (mist, rain, snow, yellow sand, underwater conditions, poor lighting, backlighting) and enhances images in real time



Cleaning device usage

Let’s Know About The Dam
OBAYASHI DAM WORLD
https://www.obayashi.co.jp/en/damworld/

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