ICOLD & APG Symposium
on
Sustainable Development of Dams & River Basins

# Unmanned maintenance work with underwater Remotely Operated Vehicle (ROV) for discharge facilities of dams

by

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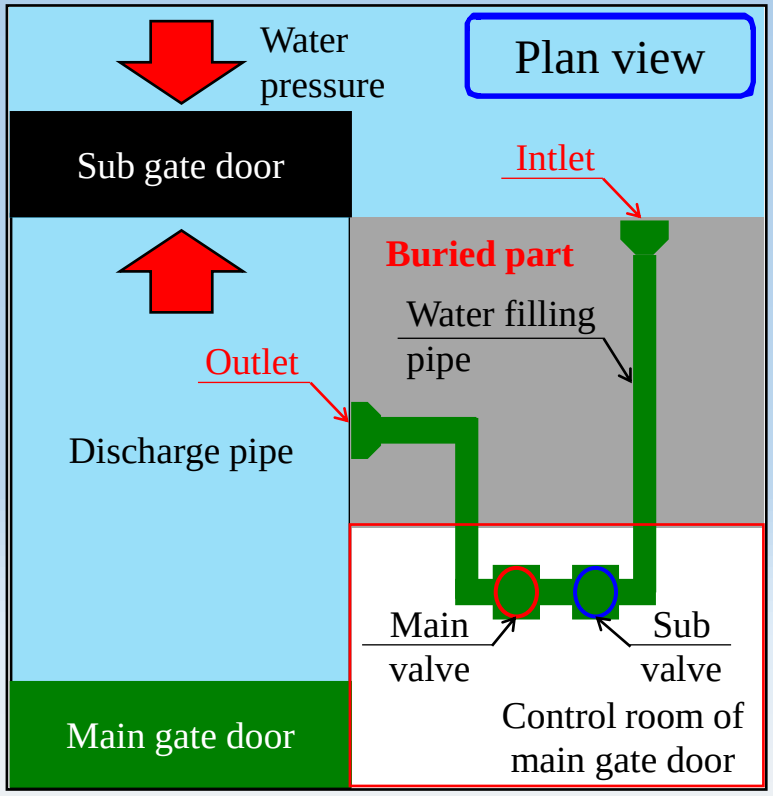
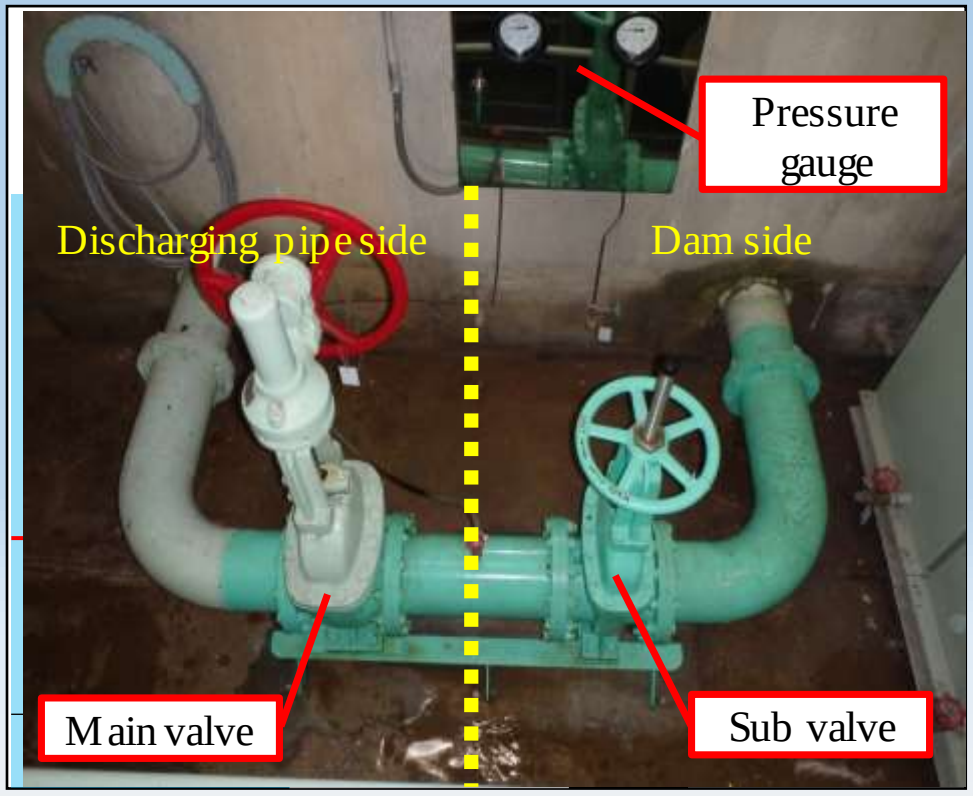
# 1. Structure of water filling system

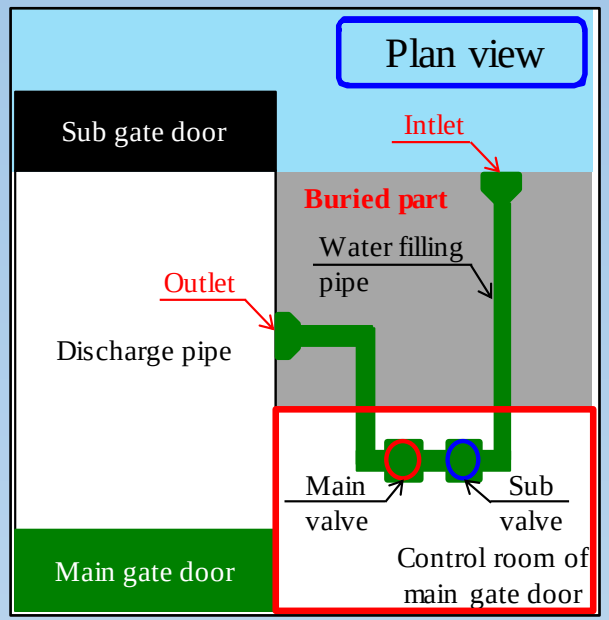
The water filling system is a facility for filling the discharge pipe. The inspection and maintenance of the main gate are carried out after closing the sub gate and empty the discharge pipe.

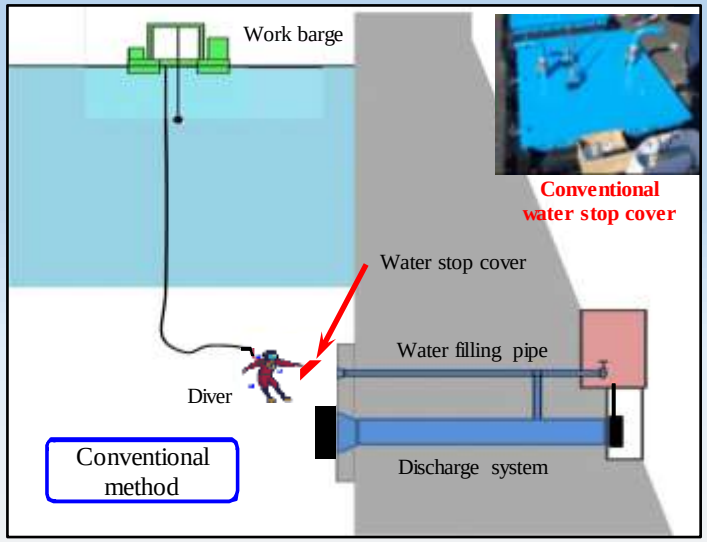
After the maintenance work, we pour water into the discharge pipe because we can not open the sub gate door with only water pressure of upstream. So using this water filling system to balances the water pressures of upstream and downstream of the sub gate, we can open the sub gate.



# 2. Background of developing an unmanned maintenance technique



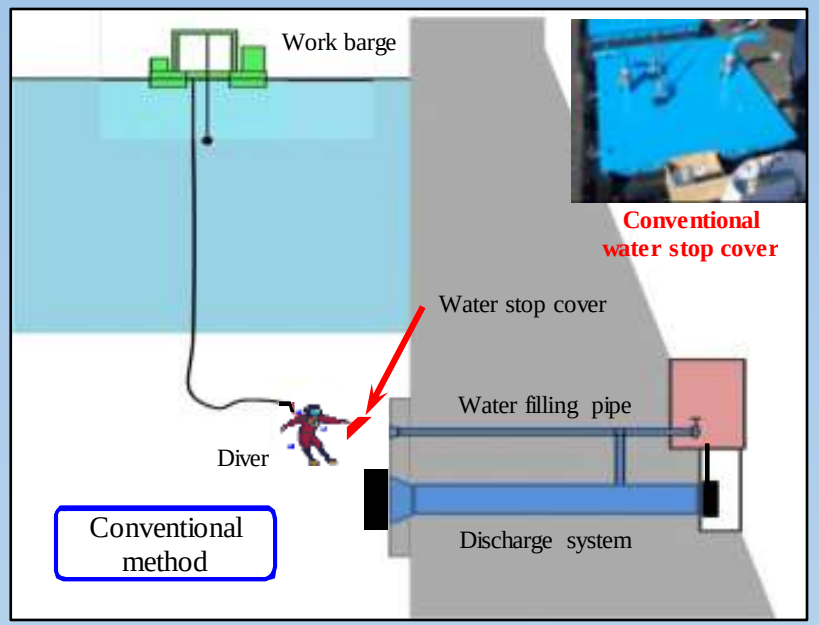

The water filling system requires regular maintenance of pipes and valves.

If the water filling system needs to be maintained upstream of the sub valve, water must be shut off at the inlet of the water filling pipe.

Divers installed and removed the water stop cover at the inlet.

**High risk and high cost**

# 3. Technical methods to stop water into the water filling pipe




## 1. Conventional method to install a water stop cover

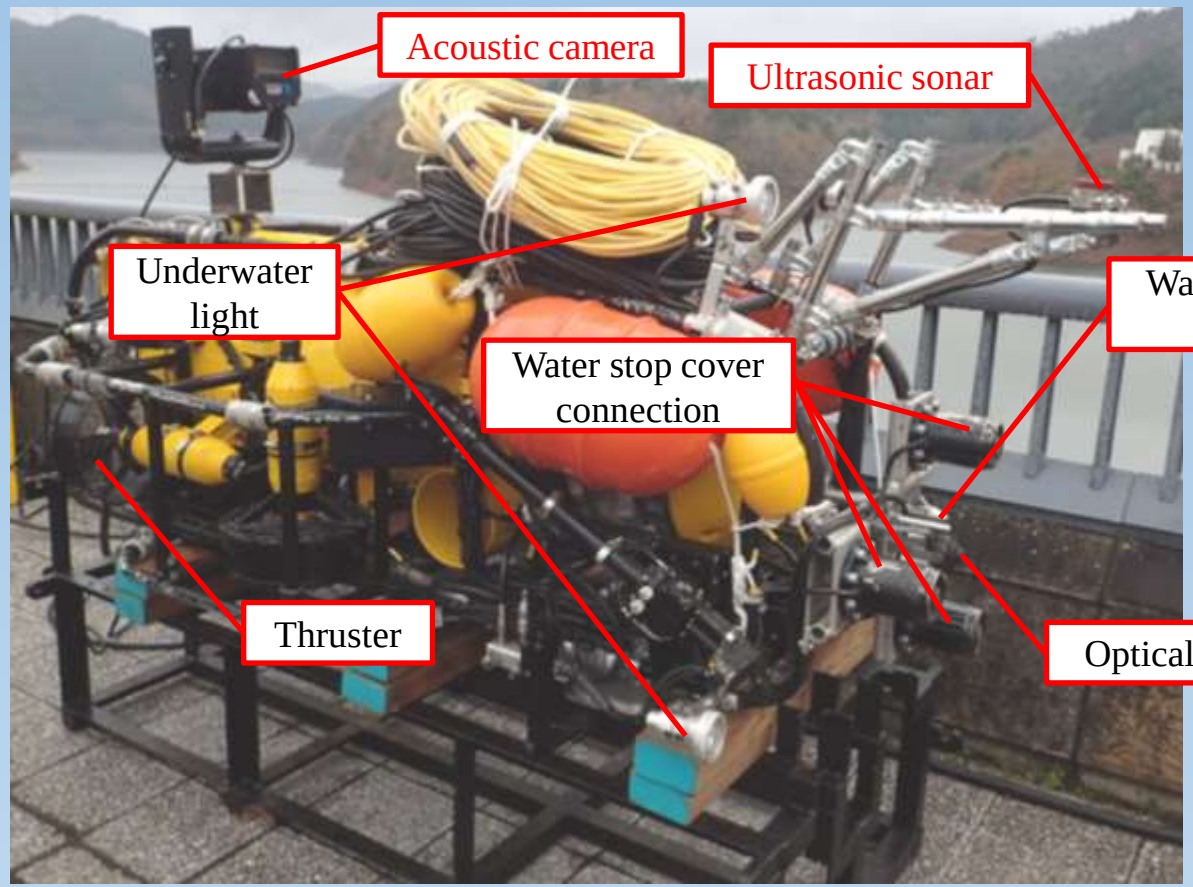
A method of attaching a water stop cover to the entire inlet and stopping water.

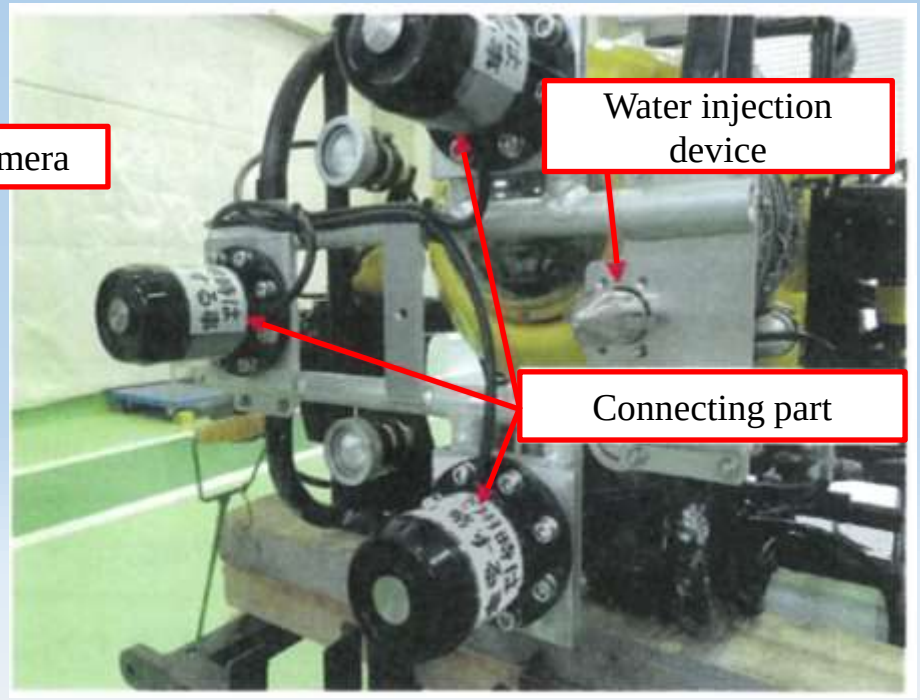
The water stop cover needs to be manufactured according to the shape of the inlet of the water filling pipe at each dam, then installed and removed by a diver.

We decided to take unmanned water stop cover installation method since it can be used for any pipe shape and material and has high applicability.

As a means of unmanned maintenance work, we decided to utilize an underwater ROV.

# 4. Underwater ROV



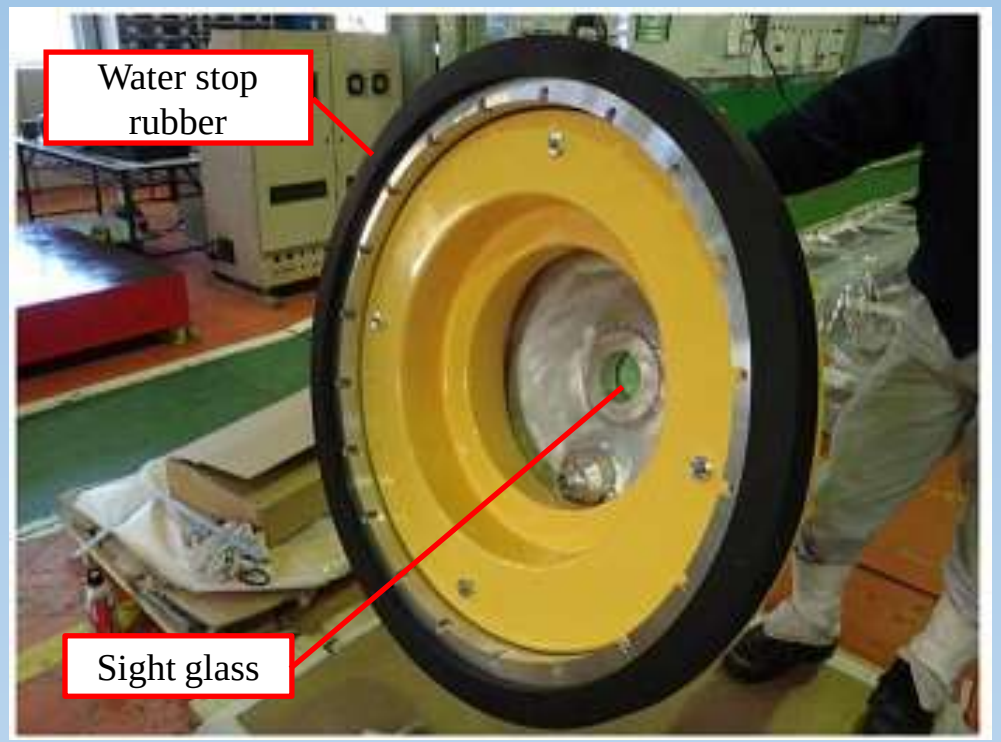

**Underwater ROV**

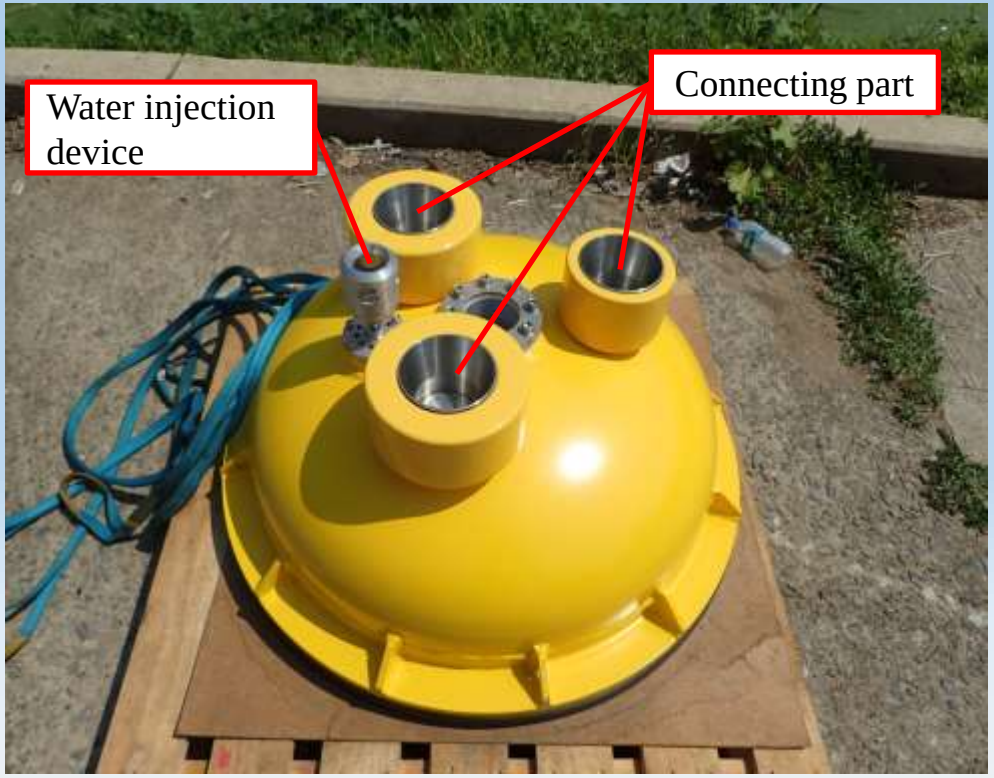
L:1.92m × W:1.03m × H:0.71m

**Underwater ROV ＋ a water stop cover**

L:2.45m × W:1.03m × H:0.96m

# 4. Underwater ROV




**Water stop cover**

Material: aluminum

Dimensions:

inner dia. 800mm

Outer dia. 960mm

Weight: 88.5kg (in the air)

Pressure resistance : 80m$H_2O$

# 5. Demonstration tests toward practical application

## Functions required for an underwater ROV

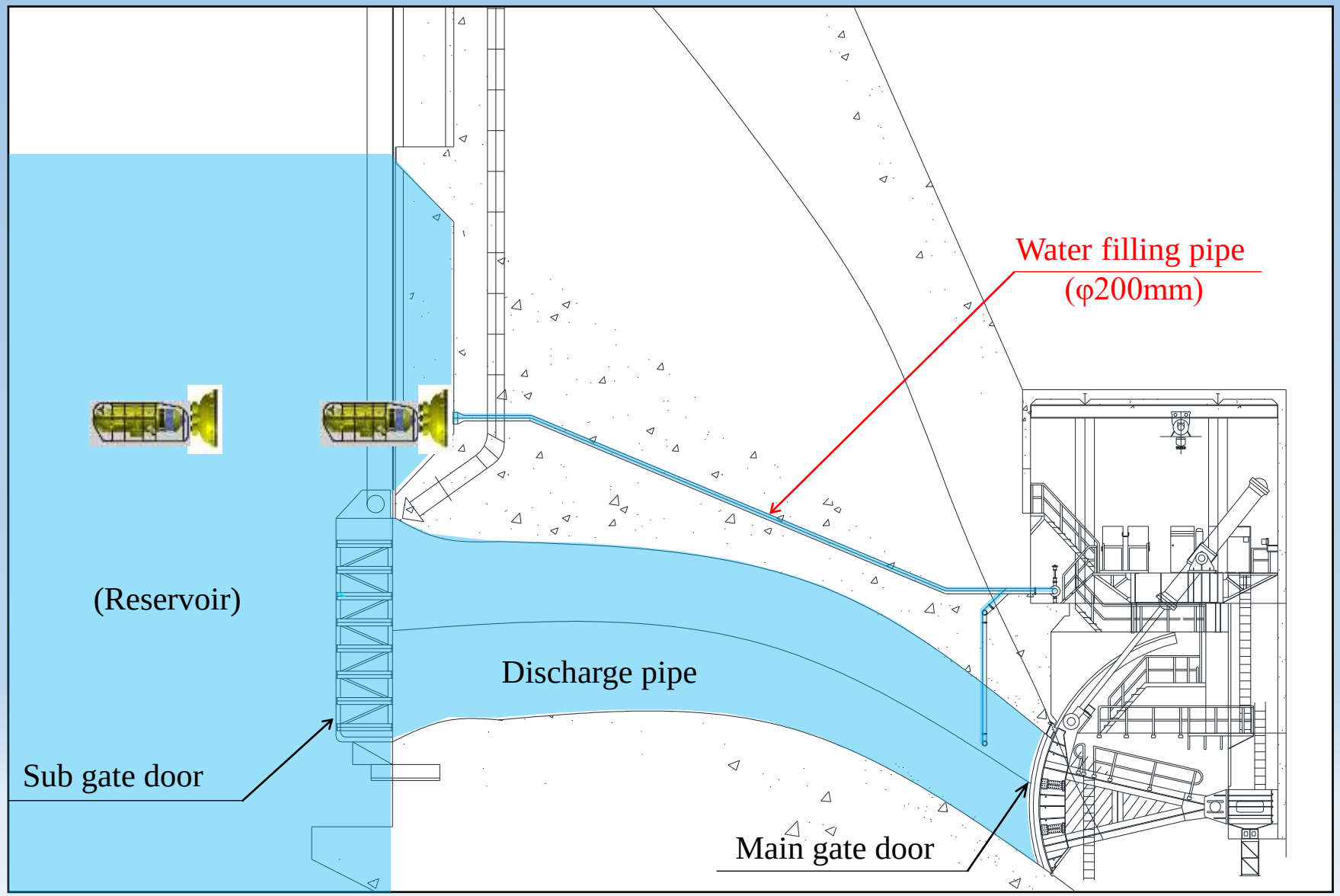
- Water stop mechanism for uneven concrete surface
- Attaching/detaching mechanism between the underwater ROV and the water stop cover
- Water injection mechanism to the water filling pipe
- Good operability

## Functional test results in a large water tank

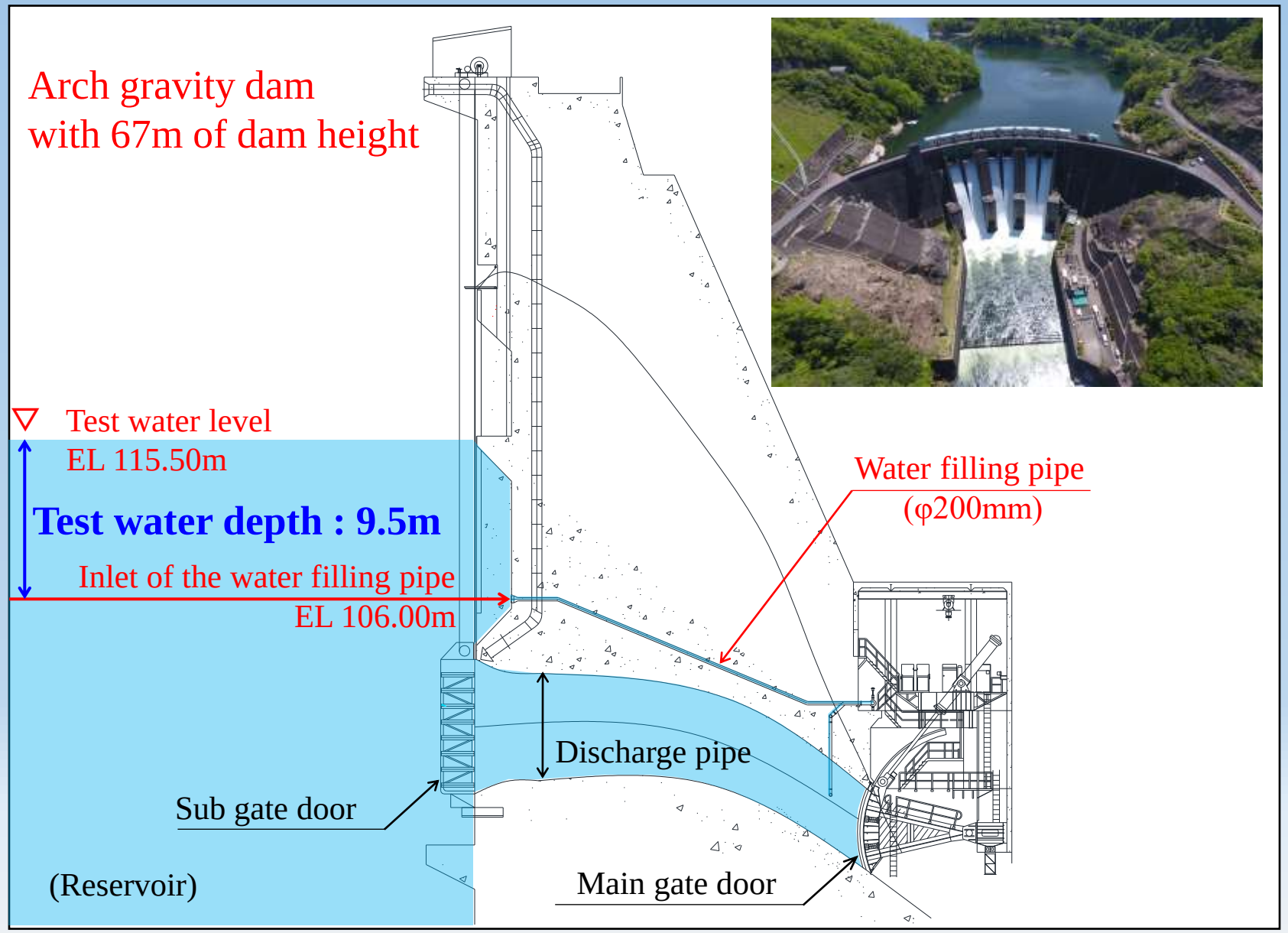
- Water stop mechanism : Good
- Attaching/detaching for the water stop cover : Good
- Water injection mechanism : Good
- Operability : Good

Demonstration tests at Takayama Dam and Hiyoshi Dam

# 5. Demonstration tests toward practical application



# 5-1. Demonstration test at Takayama Dam



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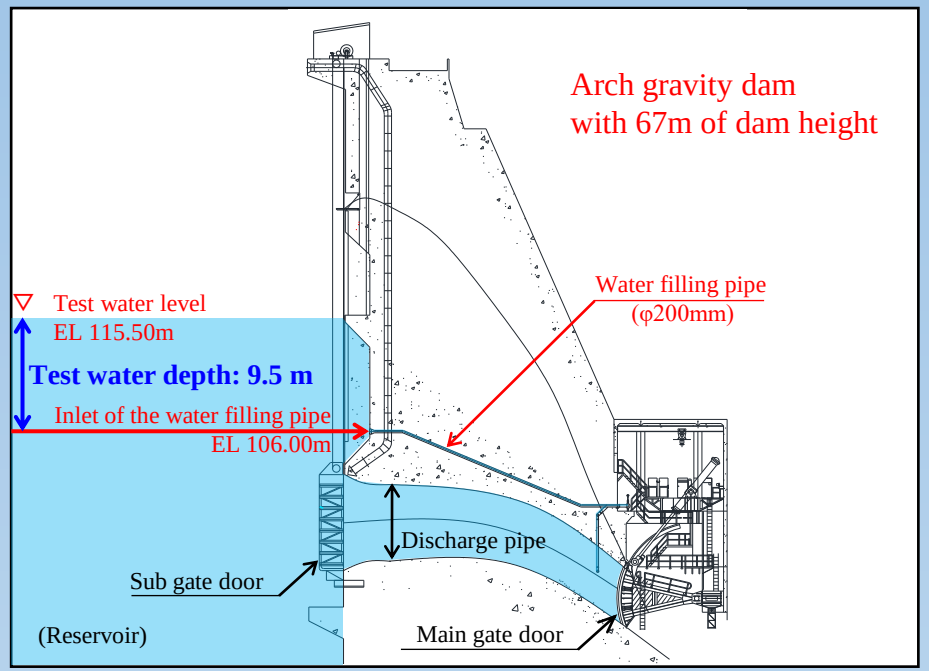
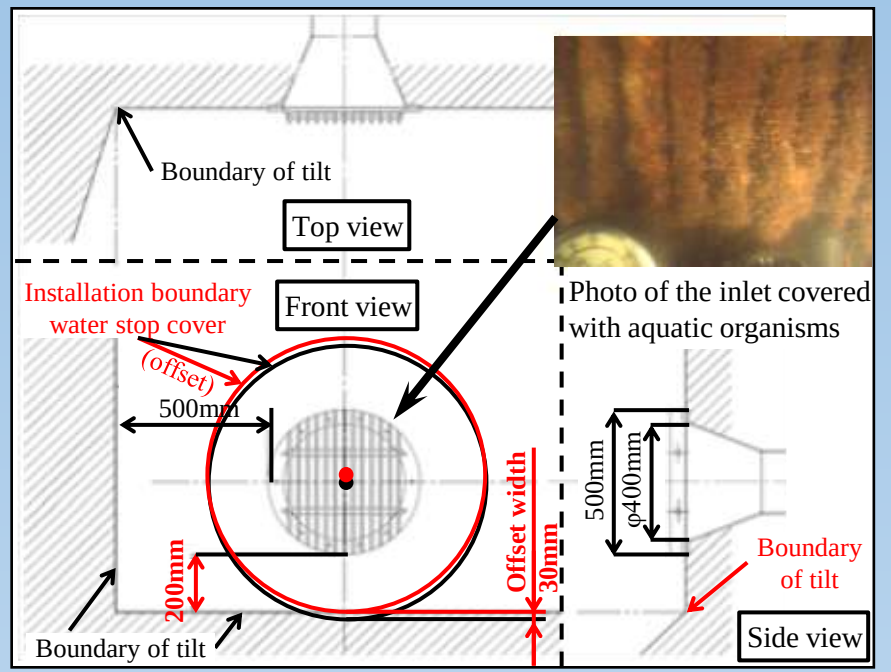
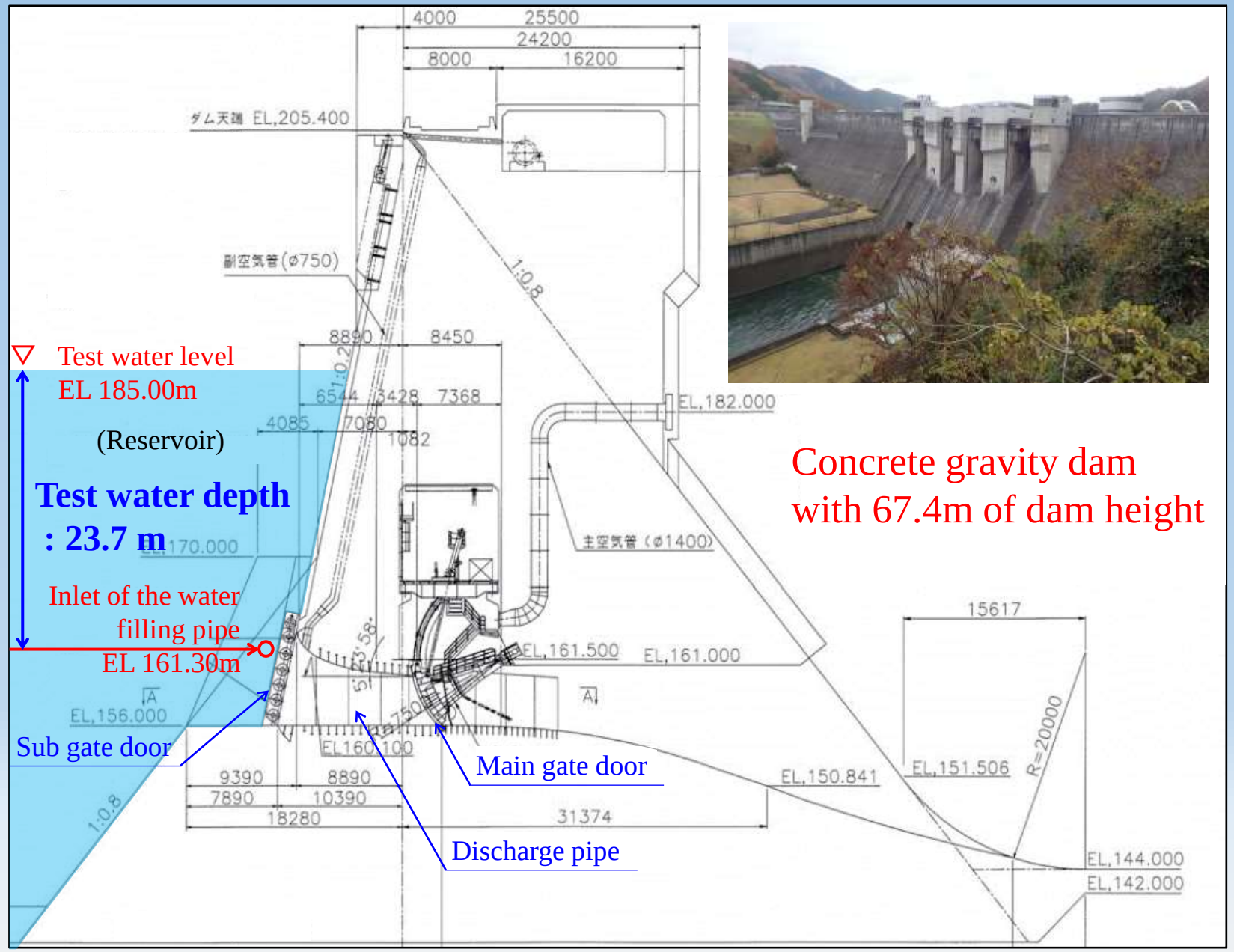



## Results and needed improvements

- Water stop mechanism : Good
- Attaching/detaching for the water stop cover : Need improvement
  ⇒ Strengthening electromagnets
- Water injection mechanism : Good
- Operability of the underwater ROV : Need improvements
  ⇒ Additional underwater lights and cameras
  ⇒ Additional function to adjust the buoyancy of ROV

# 5-2. Demonstration test at Hiyoshi Dam



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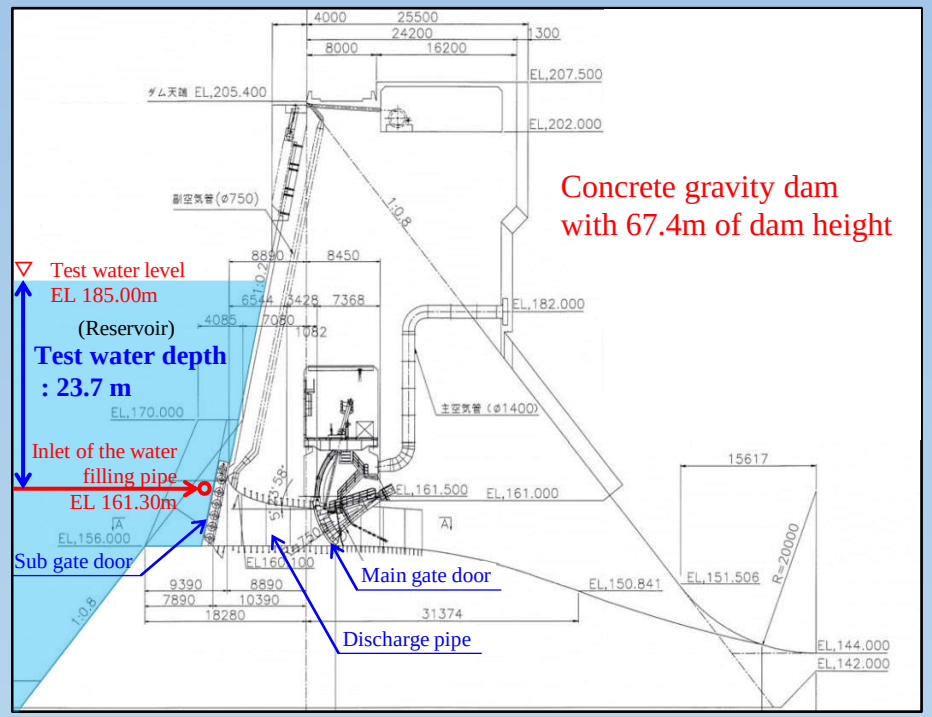


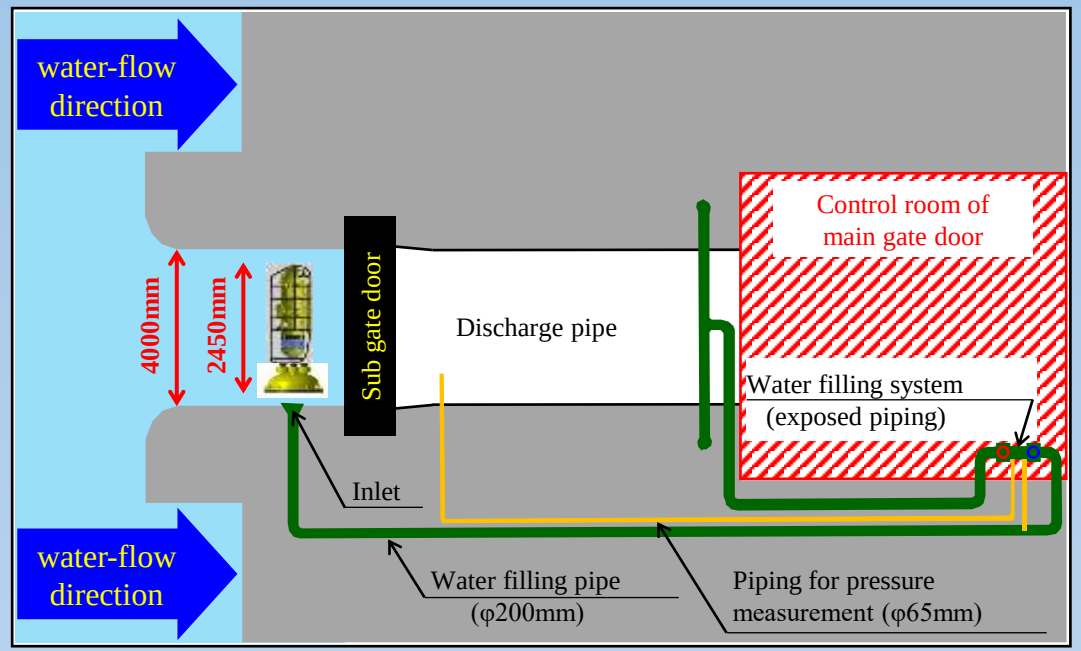


## Results and needed improvements

- Water stop mechanism : Good
- Attaching/detaching for the water stop cover : Good
- Water injection mechanism : Good
- Operability of the underwater ROV : Need improvements
  - ⇒ Reexamination of installation position and shooting angles of underwater lights
  - ⇒ Protection of underwater lights with covers

# 6. Conclusions

From the test results of Takayama Dam and Hiyoshi Dam, it was revealed that unmanned maintenance work for discharge facilities of dams using an underwater ROV is feasible.

Some areas that will require improvements found during the demonstration tests will be improved as follows.

In addition, if an ROV can be developed exclusively for this maintenance, the following improvements are needed.

Unmanned maintenance work with an underwater ROV for discharge facilities of dams is a technique jointly developed and patented by the Japan Water Agency and Sato Tekko Co., Ltd.

**Thank you for your attention.**

⇒ Connect the power cable to the water stop cover (The power cable will also serves as a wire to prevent the water stop cover from falling)

- Protection of underwater lights with covers

**Points to be improved when developing a ROV dedicated to this maintenance**

- Downsizing an ROV
- Strengthening thrusters
- Expansion of attitude control