Tokuyama Dam

--The Largest Rockfill Dam in Japan
Creating a Beautiful Reservoir in Harmony with Nature --

Commissioned by: the Japan Water Agency

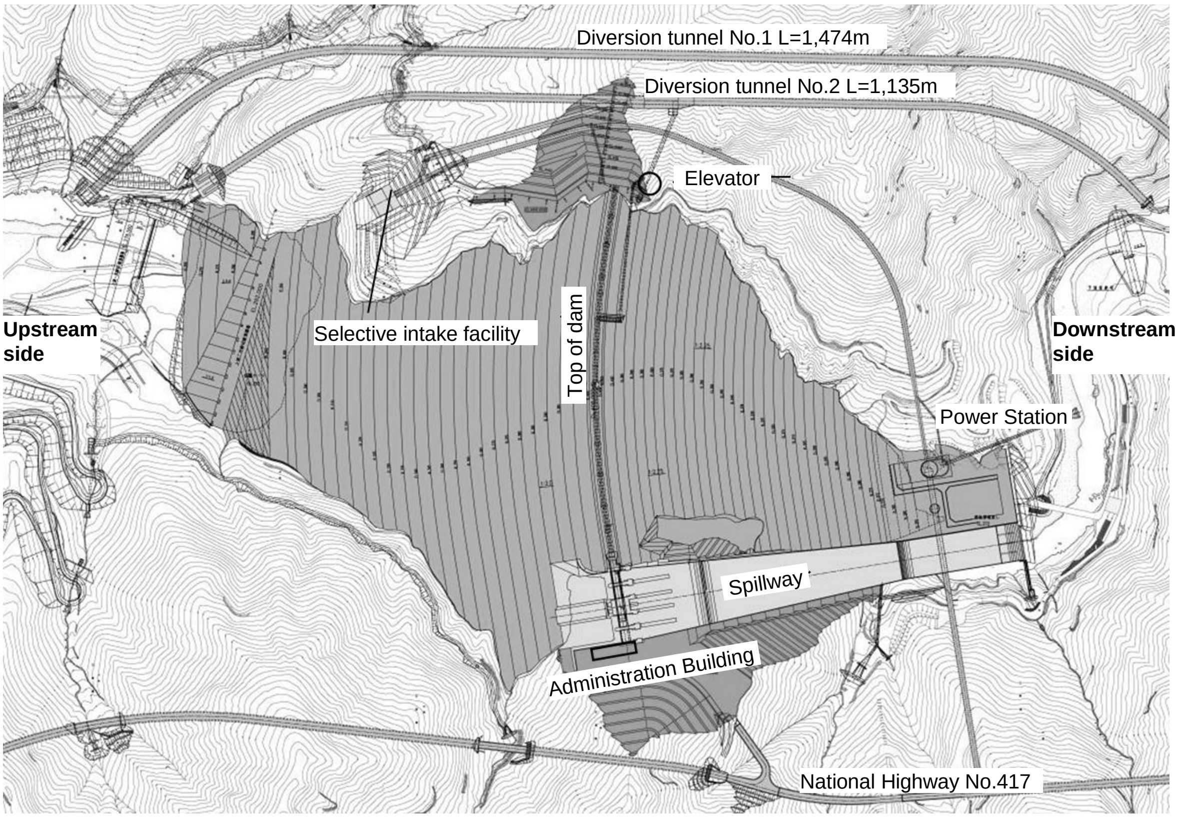

Figure 1. Plan

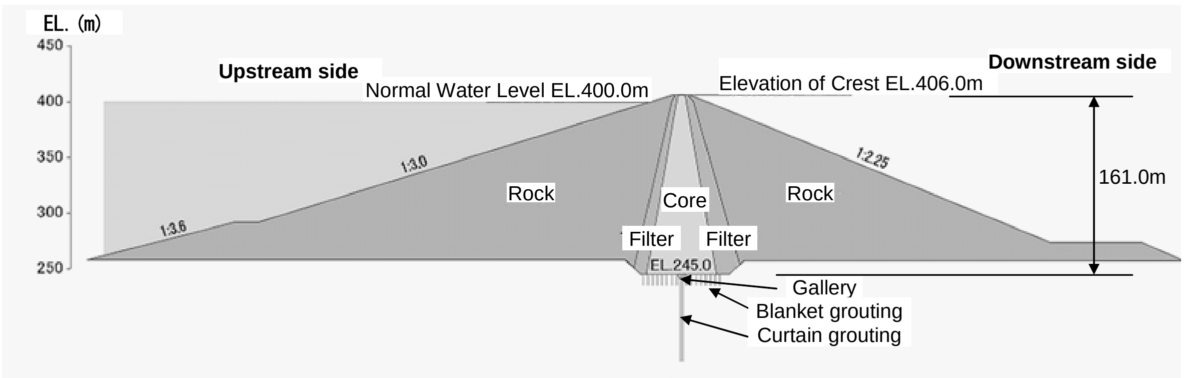

Figure 2. Cross Section

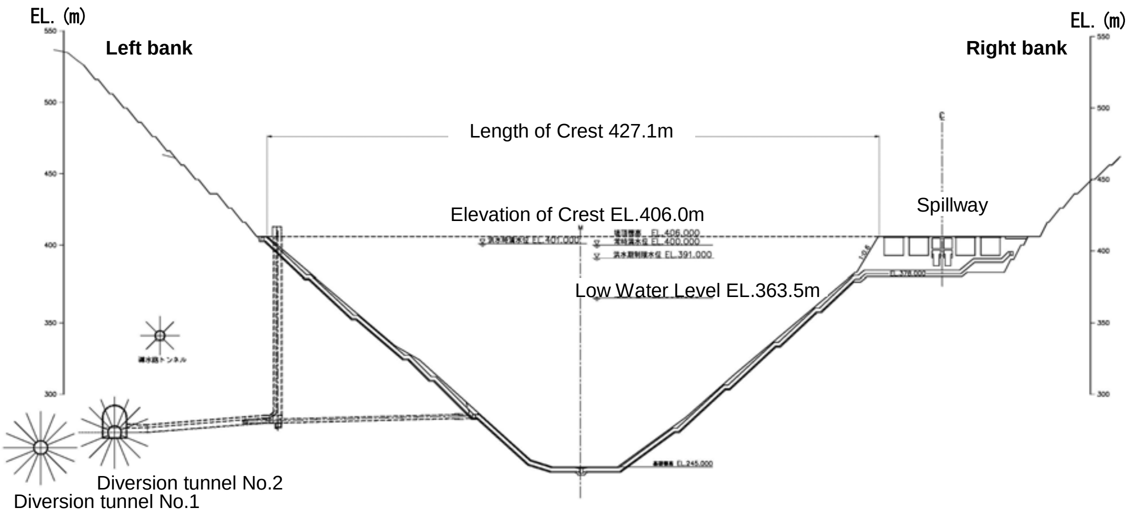

Figure 3. Longitudinal Section of Dam Axis

Table 1. SPECIFICATIONS

ITEM		SPECIFICATIONS
Purpose(s)		Flood control, Nonspecific use/ecological discharge, Water supply, Irrigation, Power generation
Location		Chubu Region (Ibigawa town, Ibi-gun, Gifu Pref.)
River		Ibi River, Kiso River System
Catchment Area		254.5 k m^2
Completed		2008
Reservoir	Total Storage Capacity	660,000,000 m^3
	Effective Storage Capacity	380,400,000 m^3
	Reservoir Area	Approx. 13 km^2
Dam	Type	Central Core Type Rockfill Dam
	Height	161 m
	Length of Crest	427.1 m
	Volume	Approx. 13,700,000 m^3
Spillway	Crest Spillway	Orifice Radial Gates W 4.1m × H 4.1m × 2 Gates
	Emergency Spillway	Radial Gates Overflow W13.4 m × H10.95 m × 4 Gates
	Design Flood	4,200 m3/s
Water Discharge System for Utilization	Water discharge Gates	Main Gate: Jet Flow Gate, φ 1,900 mm Auxiliary Gate: High Pressure Slide Gate, φ 2,150 mm
Intake Equipment	Water Intake Gate	Straight Multi-step Gate W 11.0 m × H 45.5 m × 5 Steps-shutters
Primary Firms	Dam Body	Kumagai Gumi Co.,Ltd, Taisei Corp., Asunaro Aoki Construction Co.,Ltd.
	Spillways	Obayashi Corp., Shimizu Corp., Dainippon Construction
Power Station	Operator(s)	Chubu Electric Power Co., Inc.
	Start of commercial operation	Unit 1：March 24,2016 Unit 2：May 15, 2014
	Type	Conventional
	Turbines	Francis-type
	Installed capacity	Unit 1: 139,000 kW, Unit 2: 24,300 kW The total output during simultaneous operation amounts to 161,900 kW

1. Background Notes

The upstream basin of the Ibi River, where the Tokuyama Dam was constructed, was designated as a "survey district" under the Electric Power Development Promotion Act (1957). The Tokuyama Dam Project started with a pre-execution planning survey held by J-Power in 1971. In 1976 the Project Plan was approved by the Japanese Government and the Project was taken over from J-Power to the Water Resources Development Public Corporation (WARDEC) (precursor of today's Japan Water Agency (JWA)). The relocation of all 466 households in the planned reservoir area was completed in 1989. The construction of the dam body began in 2000 and ended in 2006. An initial impoundment followed for 2 years. In 2008 the operation of the dam started and the Project finally ended.

The Tokuyama Dam is the largest rockfill dam in Japan(Top for the reservoir capacity of about 660 million m^3 and dam body of about 13.7 million m^3. The third rank for the submerged area of 13 km^2 and dam height of 161m).

2. Site Factors

The geology at the dam site has bedrock of Paleozoic/Mesozoic Mino Zone, covered with a Quaternary layer. The bedrock consists of basalt (lava), tuff, chert, and slate. On the dam axis section, basalt and tuff are distributed throughout the foundation, with blocks of chert distributed between them. The slate is distributed near the foundation under the spillway overflow part.

In the basement of reservoir, the Ibi River Fault runs continuously NW-SE towards the upstream Ibi River. Therefore the Neodani Fault which was the epicenter of the massive Nobi Earthquake in 1891 is nearby, the dam's earthquake safety factor is k = 0.18, for the earth quake safety.

3. Design

3.1 Effective Use of Sand and Gravel from an existing Dam

For construction of Tokuyama Dam, some 840,000 m^3 of sand and gravel were collected from the sediments in the reservoir of Yokoyama Dam located further downstream. They were recycled as materials for filter or concrete aggregate of the dam site. This process resulted in reducing CO_2 emissions caused by crushing new materials, omitting alternation of 17 hectares of quarry sites, and also lowering the cost of material procurements. For Yokoyama Dam, the removal of sediment deposits meant a refreshing of the reservoir bed, and recycling them led to lowering the cost for disposing.

3.2 New Technologies and Construction Methods

New technologies and construction methods, such as construction of cofferdam by CFRD (Concrete Facing Rockfill Dam) method, a submerged fine aggregate weighing system, an automated scanning radio isotopic densimeter and management of construction process and quality by GPS managing system, were used throughout the Project. Safety was enhanced by seismic designs and verifications regarding to the presence of the Neodani Fault.

4. Construction in Practice

4.1 Fast Embanking of the Dam Body (A New Japanese Record for Dam Body Construction)

A quick collection of core materials was implemented by such heavy construction machineries as 12 m^3 wheel loaders and 46 ton dump trucks. The embankment of core was also carried out speedy by increasing the thickness of each embankment to 30 cm from 25 cm. A number of large heavy machineries such as 90 ton class ripper bulldozers, 12 m^3 class backhoes, 10.3 m^3 class tractor shovels, and 90 ton dump trucks enabled a fast collection of the massive rock-fill materials. This largest dam in Japan with the volume of 13.7 million m^3 was completed only within 26 months (excluding a winter break), setting a new Japanese record of 6.2 million m^3 embankment in a single year (Photo 1).

At the same time, the spillways were constructed at high speed using slip forms and large sliding forms, etc., and it enabled shortening the execution period and cost reduction (Photos 2 and 3).

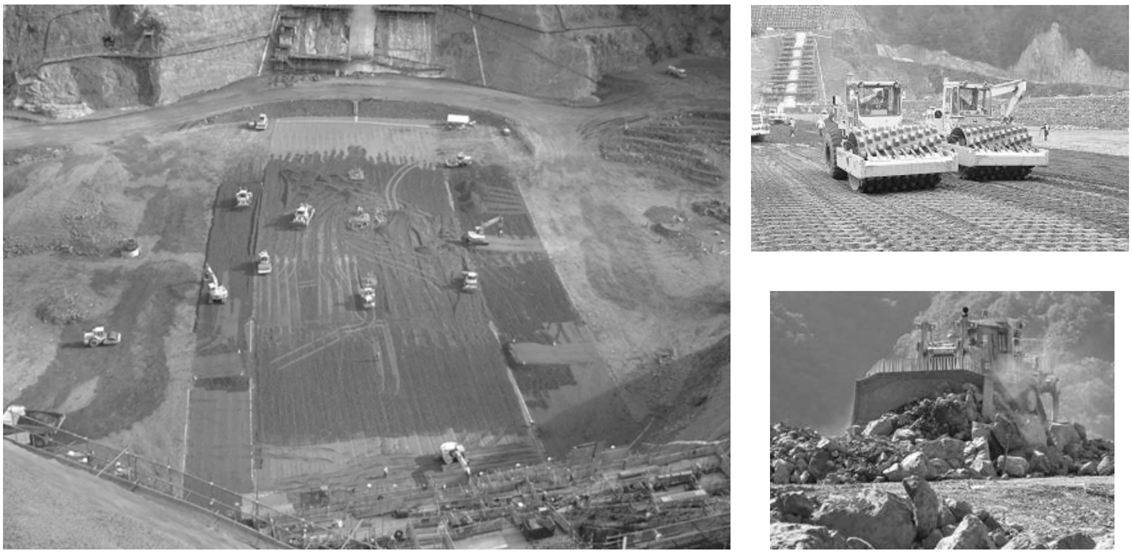

Photo 1. Tokuyama Dam at the Peak of Embanking (Compaction with 18T class vibrating tamping rollers, embankment with 90T ripper bulldozers)

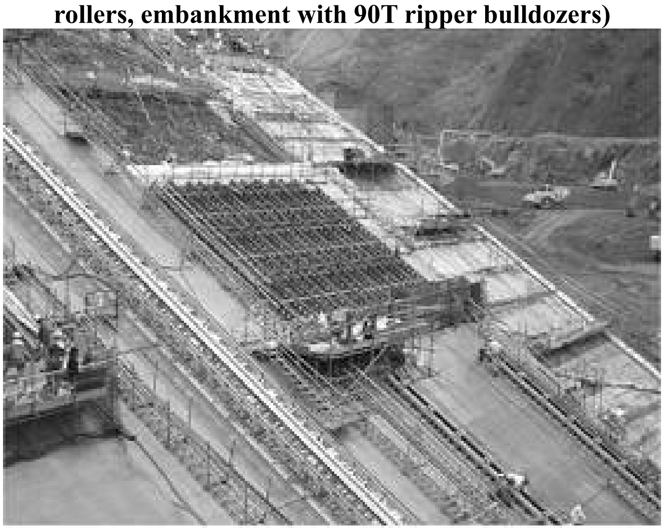

Photo 2. Construction of a Training Slip Forms

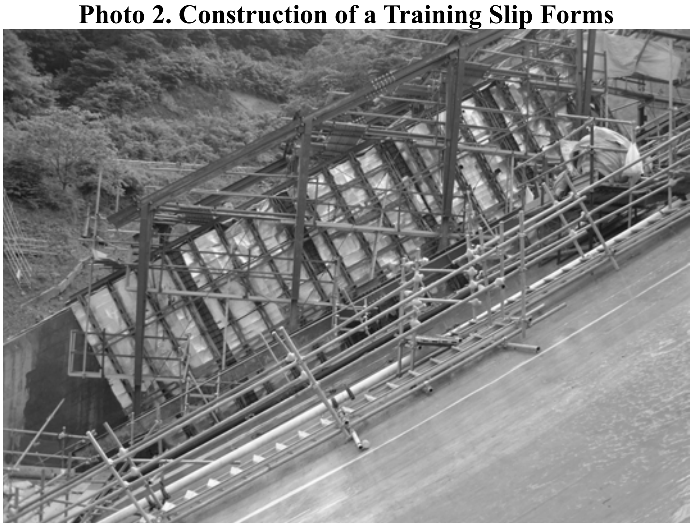

Photo 3. Construction of a Training Wall with Large Sliding Forms

4.2 Ecological Dam in Harmony with Nature

254 k m^2 natural forest, including broadleaved forest by 90%, in the upstream basin was municipalized to preserve the water resource environment. Installation of temporal equipment in the planned reservoir area and making 70 % of the access roads (total length of 12.5 km) into tunnels contributed greatly to conserve the

natural environment with a rich diversity of flora and fauna. Restricting deforestation and cutting of trees inside the dam reservoir formed an ecotone, a transition area between two different biomes. This also improved the scenery along the reservoir shoreline, and restricted the discharge of turbid water.

For the Tokuyama Dam Project, a large scale survey of raptors covering the entire basin was carried out. It was the first time in Japan that such a large scale survey was held. The result showed 5 pairs of golden eagle and 17 pairs of mountain hawk eagle were breeding in the basin. The CCD cameras set on the nest trees of mountain hawk eagle also revealed a number of new biological information. Basing on those findings from the survey, adjustments were made to the construction schedule, and methods of construction execution were changed to reduce noise and vibration.

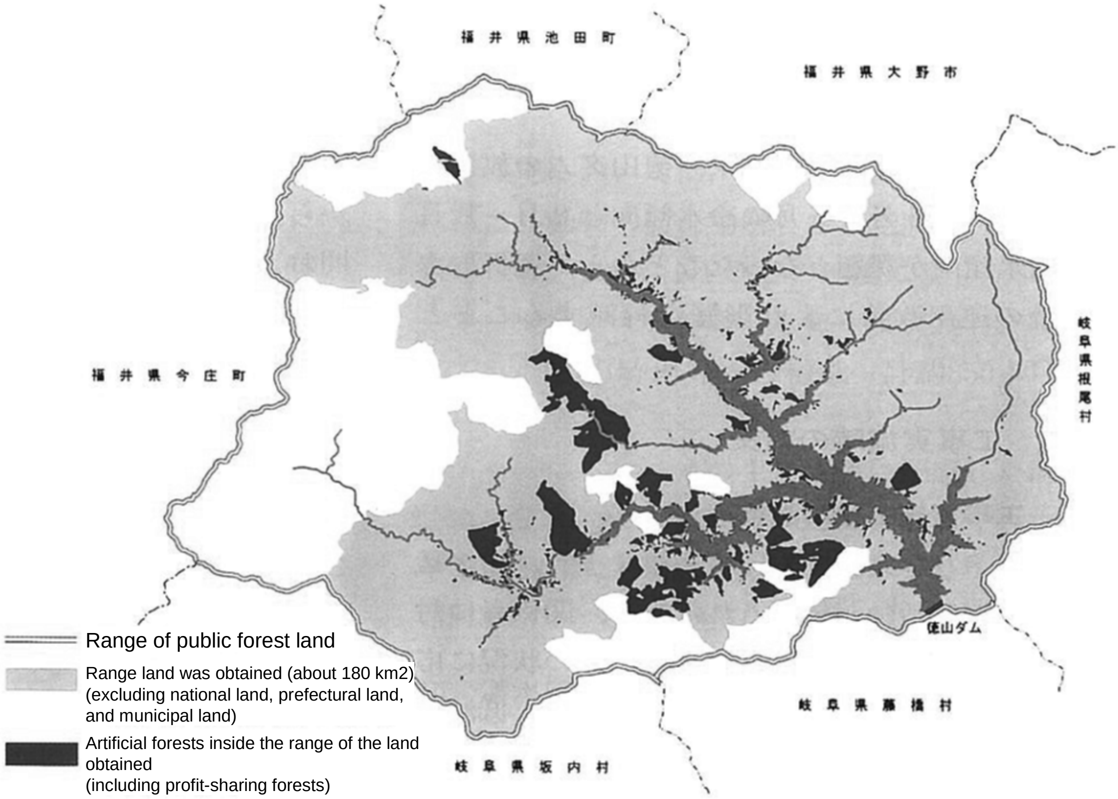

Figure 4. Municipalized Forest

5. After the Project

Various environment preservation measures had been implemented during the construction of Tokuyama Dam. The findings and evaluations gained from monitoring surveys of almost three years after the Project surely show the effectiveness of the environmental preservation measures. They also show changes in habitats coping with new environments created by the reservoir.

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