Reinforcement of dam body for Murayama-kami Reservoir

- Construction under reservoir operation, a rare instance in Japan -

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INTRODUCTION

Murayama-kami Reservoir is a facility that temporarily stores raw water drawn in from the Tama River (storage capacity is approximately 3 million m^3). Together with the neighboring Yamaguchi and Murayama-shimo Reservoirs, the storage capacity is approximately 34, 350,000 m^3, which is equivalent to approximately one week's water supply in Tokyo.

The body of Murayama-kami Reservoir is an earthfill dam with a height of 24.2 m, a crest length of 318.2 m, and a dam volume of 330,000 m^3, and has been over 90 years since its completion in 1924. In addition, the main body is sandwiched between Murayama-kami Reservoir at the upstream side and Murayama-shimo Reservoir at the downstream side. The maintenance road at the crest of dam body is a heavy traffic as a road which is open to general vehicles connecting Tokyo Metropolis and Saitama prefecture.

The Bureau of Waterworks, Tokyo Metropolitan Government (hereinafter referred to as "Tokyo Waterworks") made the seismic diagnosis on dam body since triggered by the 2011 off the Pacific coast of Tohoku Earthquake. It was found that sinking of the crest of dam body and slip deformation on the downstream side may occur, although the water storage function will not be impaired. Therefore, Tokyo Waterworks decided to make every effort to ensure the stability of the water facilities and to reinforce of dam body to prevent secondary disasters with traffic vehicles.

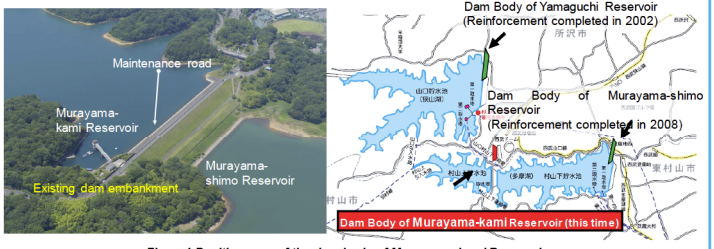

Figure1 Position map of the dam body of Murayama-kami Reservoir

Materials and Methods

1 Target performance of earthquake resistance and evaluation standards

(1) Target performance of earthquake resistance

- To ensure sufficient earthquake resistance and its function as a water source facility even if a large earthquake including an epicentral earthquake in Tokyo occurred
- Level 1 earthquake motion: To maintain sound function even in the case of an earthquake
- Level 2 earthquake motion: To maintain water storage function. To minimize damage within the reparable range

Table1 Level 2 earthquake motion used for dynamic analysis

Earthquake type	Assumed earthquake	Magnitude (Mw)	Maximum acceleration (gal)
Active fault	Tachikawa fault zone earthquake	M7.1	609
Subduction-zone (between plates)	Epicentral earthquake in Tama area	M7.3	645
Subduction-zone (in the plate)	Epicentral earthquake in Tachikawa City	M7.3	820

(2) Evaluation Standards

Table 2 Evaluation Standards for Seismic Resistance

Seismic Motion Level	Seismic Resistance Evaluation Standard	Evaluation Method
Level 1	Slide Safety Ratio is 1.2 or higher	Seismic Intensity Method
Level 2	Subsidence at top of dam is 1.0 m*1 or less	Dynamic Analysis

2 Diagnostic results of earthquake resistance of the current dam body

(1) Level 1 of seismic motion: As a result of checking by the seismic coefficient method, the slip safety factor Fs at the downstream side of the dam body (Murayama-shimo Reservoir side) was less than 1.2 at the time of the earthquake.

(2) Level 2 of seismic motion: As a result of checking by the dynamic analysis, the crest of dam body sunk by about 2 m (Figure 2) at the time of the earthquake.

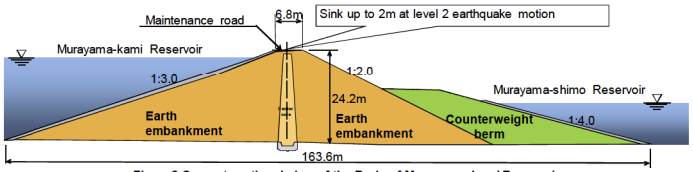

Figure2 Current sectional view of the Body of Murayama-kami Reservoir

3 Major technical issues for reinforcement of dam body

(1) Securing water storage function

- It is necessary to secure as much storage amount as possible even during construction

(2) Securing road function

- It is necessary to secure the road function during construction because of heavy traffic of the maintenance road

Results and Discussion

1 Basic policy of the construction method of reinforcement of dam body

- Construction method for reinforcing dam body will be "counterweight berms," which is structured and highly reliable method adopted at Yamaguchi and Murayama-shimo Reservoirs
- Counterweight berms on the downstream side of the existing dam body will be once removed, and effectively used as material of reinforced embankment (mixed with purchased crushed stone) due to heterogeneous and low-intensity material
- Securing vehicle traffic to the crest of dam even during the construction period
- The storage amount of Murayama-shimo Reservoir will be secured as much as possible to ensure stable water supply even during the construction period, based on recent drought circumstances, etc

2 Material of reinforced embankment

- Material for the reinforced embankment is used as counterweight berms of the existing dam body and gravel soil from the left bank of the Murayama-shimo Reservoir
- Material for the reinforced embankment is mixed with crushed stone and crushed sand to enhance strength

3 Sectional view of reinforcement of dam body

- Reinforced embankment shape that satisfies seismic resistance.
- "Drain zone" is installed at the boundary between the existing dam body and the reinforced embankment in order to avoid raising the seepage line in the reinforced embankment.

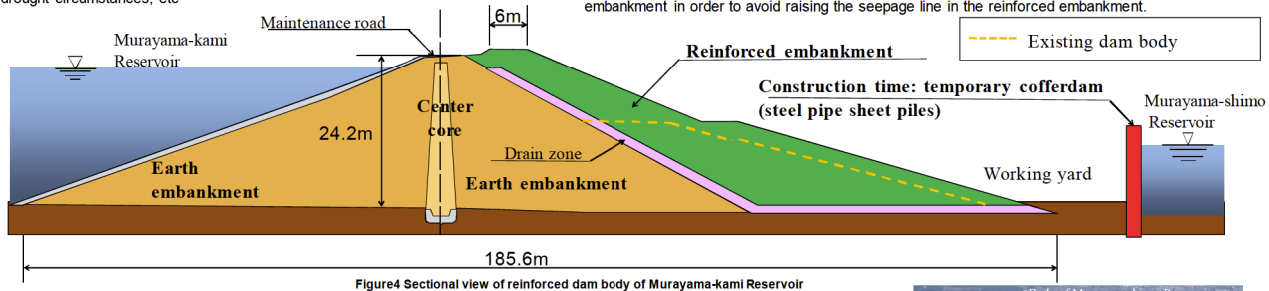

Figure4 Sectional view of reinforced dam body of Murayama-kami Reservoir

4 How to maintain water storage function during construction

- In order to secure the storage amount in Murayama-shimo Reservoir as much as possible even during construction, the Tokyo Waterworks planned to install a temporary cofferdam on the downstream side of the existing dam embankment within a necessary minimum range (Figure 5)
- The temporary cofferdam was made to be a structure capable of responding to the full water level of Murayama-shimo Reservoir (water depth of approximately 10 m). It was a self-standing "cofferdam by steel pipe sheet piles" which is advantageous in terms of economy, workability, and shortening of construction period
- As a result, we achieved to secure approximately 97% of the storage capacity of Murayama-shimo Reservoir

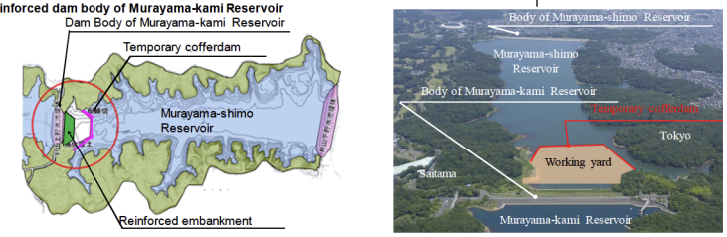

Figure5 Conceptual diagram of water storage situation during reinforcement construction of dam body

Conclusions

- The dam remains sound even in the event of a major earthquake, which makes possible to firmly secure raw water for waterworks and protect the lives and property of residents living around the dam.

References

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