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OUTLINE AND EFFECTS OF PERMANENT SEDIMENT MANAGEMENT MEASURES FOR MIWA DAM *

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INTRODUCTION

As a redevelopment project for Miwa Dam in Japan, the Mibu River Comprehensive Development Construction Office has been conducting excavation of the deposited sediment for recovering the reservoir capacity, promoting permanent sediment management measures for controlling sedimentation in the reservoir. The permanent sediment management measures involve the “flood bypass tunnel” for controlling the inflow of wash load into the reservoir, as well as “intra-reservoir sediment management facilities” that discharge the wash load included in the turbid waters flowing into the reservoir, which are led into it without bypassing for the purpose of water level recovery or flood control in connection with water utilization.

This paper summarizes the project outline and trial run of the flood bypass tunnel that was completed in May 2005.

* *Mesures permanentes de gestion des sédiments au barrage de MIWA : Description et Résultats*

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1. OUTLINE OF MIBU RIVER BASIN

Fig. 1
Tenryu River Basin
Cours du fleuve Tenryû

Mibu River originates from Mt. Senjogatake (also called the queen of Japan's South Alps) and is the largest tributary of Tenryu River, with the total stream length of 60 km and the basin area of 481 km^2. It flows into Tenryu River in Ina City at 40 km downstream from Lake Suwa.

Mibu River has a complex stream profile due to the complicated surrounding geography along the median tectonic line. The average bed slope at its downstream is 1/100, steeper than Tenryu River, exhibiting a typical fan delta profile.

Due to the rough terrain as exemplified by the South Alps mountains and complicated geological features along the median tectonic line as mentioned above, there are a number of landslide scars in upstream areas, producing a large amount of soil.

The Mibu River basin is located in Ina City. Fig1 shows the basin of Tenryu River.

2. BACKGROUND OF MIWA DAM REDEVELOPMENT PROJECT

The flood control plan at the time of constructing Miwa Dam assumed the maximum inflow for 100-year probable flood to be 1,200 m^3/s and the maximum outflow to be 300m^3/s. Also, for the purpose of flood prevention of Mibu River and Tenryu River, sediment capacity of about 6.6 million m^3 was planned and secured, which corresponds to a 40-year sediment level. In August 1959, however, right before the completion of construction, a heavy flood which recorded flood discharge that almost reached the design high water discharge with a maximum flow of 1,182 m^3/s, occurred. Within 3 years starting from this event to the "Showa 36 (1961) Disaster," one of the most destructive floods in Ina Valley's history, a total of about 6.8 million m^3 of soil flowed in the reservoir, and this already exceeded the design sediment capacity. In 1982, the largest flood of Mibu River that recorded the flood discharge of 1,321 m^3/s exceeding the design high water discharge at the Miwa Dam occurred, resulting in about 4.3 m^3 new sediment only within this year, and the succeeding flood in 1983 delivered of about 1.6 million m^3 sediment.

Such repeated floods have brought an enormous quantity of soil into the Miwa Dam reservoir, which has amounted up to about 20 million m^3 since the completion of the dam.

During this period, emergency measures such as excavation and removal of sediment have been carried out in the reservoir, but they have proved insufficient for a large amount of soil flowing in. Therefore, drastic solutions have been necessary. Fig. 2 shows the transition in sediment volume, while Fig. 3 indicates the longitudinal changes of sedimentation. Photo 1 is the situation of sedimentation in 1999.

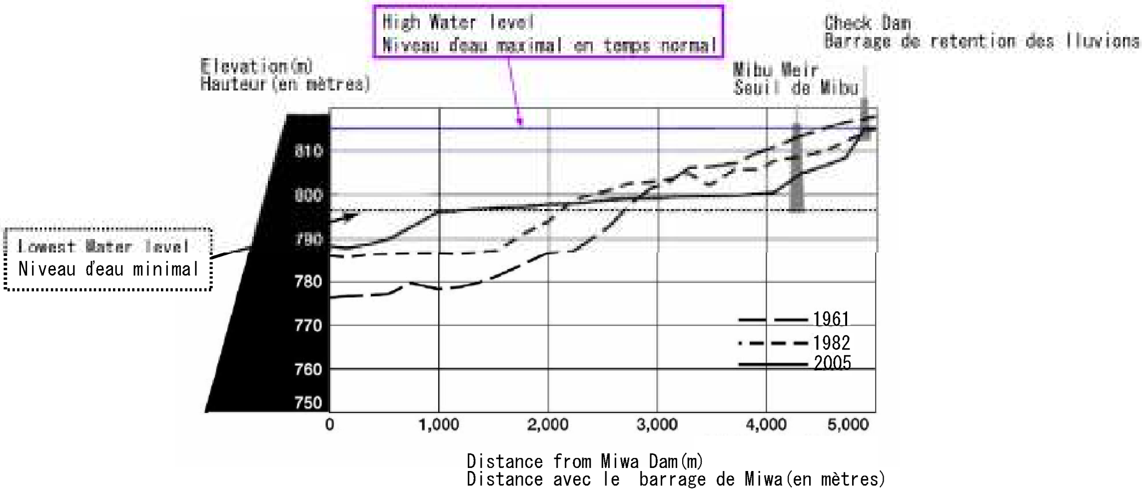


Fig. 2

Transition in Sedimentation Status in Dam Reservoir

Évolution des alluvions dans le lac de rétention du barrage

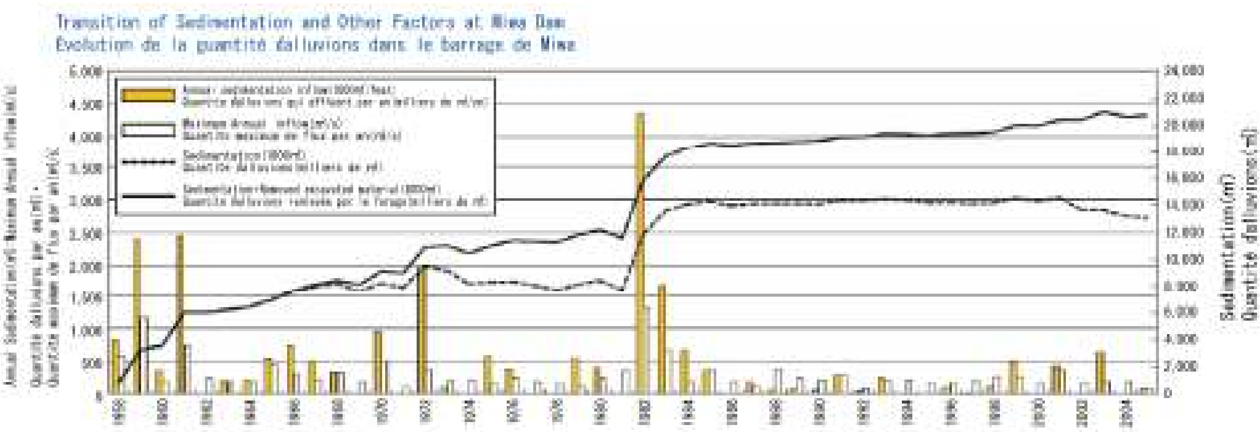


Fig. 3

Transition in Sedimentation and Related Factors at Miwa Dam

Évolution de la quantité d'alluvions déposée au barrage de Miwa

3. HISTORY OF MIWA DAM REDEVELOPMENT PROJECT

Photo 1
Miwa Dam Reservoir (1999)
Lac de rétention de Miwa (Photo prise en 1999).

Since 1981, consideration had been independently given to Miwa Dam Redevelopment Project until 1988 when it was adopted as a new construction project and named as Mibu River Comprehensive Development Project jointly with another construction project for Tokusa Dam located upstream of Miwa Dam that had been already in commission. In 1994, the check dam was completed as a tentative facility of Miwa Dam, and the excavation of the reservoir sediment started in 2000. In 2001, construction of the permanent sediment management facilities was commenced. In 2005, a flood bypass tunnel and a diversion weir were completed.

4. OUTLINE OF MIWA DAM REDEVELOPMENT PROJECT

4.1. SEDIMENT EXCAVATION

Sediment excavation is conducted for maintaining the existing flood control and water utilization functions of Miwa Dam by removing the sediment in the reservoir. In the beginning, slurry transport was mainly considered, but the actual excavation was planned to be carried out when the reservoir's water level gets lower, aiming at the low cost of land excavation and transportation by dump trucks. Before, about 2 million m^3 has been excavated and the removed material was effectively reused for improving local agricultural fields. (Photos 2,3)

Photo 2

Excavation of Reservoir Sediment

Excavations des alluvions du lac de rétention

Photo 3

Improving Farm Fields in Ichinose Area

Installation en champs du district de Ichinose

4.2. PERMANENT SEDIMENT MANAGEMENT MEASURE

In the redevelopment project, consideration was given to the inflow volume of soil as well as such physical characteristics as grain size based on the obtained data after completion of Miwa Dam. About three fourths of sediment is fine sand called wash load with an average grain diameter of 0.017 mm which usually flows in a floating state in the water during floods. Consequently a measure was considered to discharge wash load to the downstream of Miwa Dam during flood while avoiding sedimentation at Takato Dam located downstream.

Permanent sediment management measure consisted of the construction of a “flood bypass tunnel” designed to reduce inflow of wash load into the reservoir, and “intra-reservoir sediment management facilities” for discharging wash load after sedimentation when the flood water is led into the reservoir without bypassing for the purpose of water level recovery and flood control in connection with water utilization. (Fig. 4, 5, Table 1)

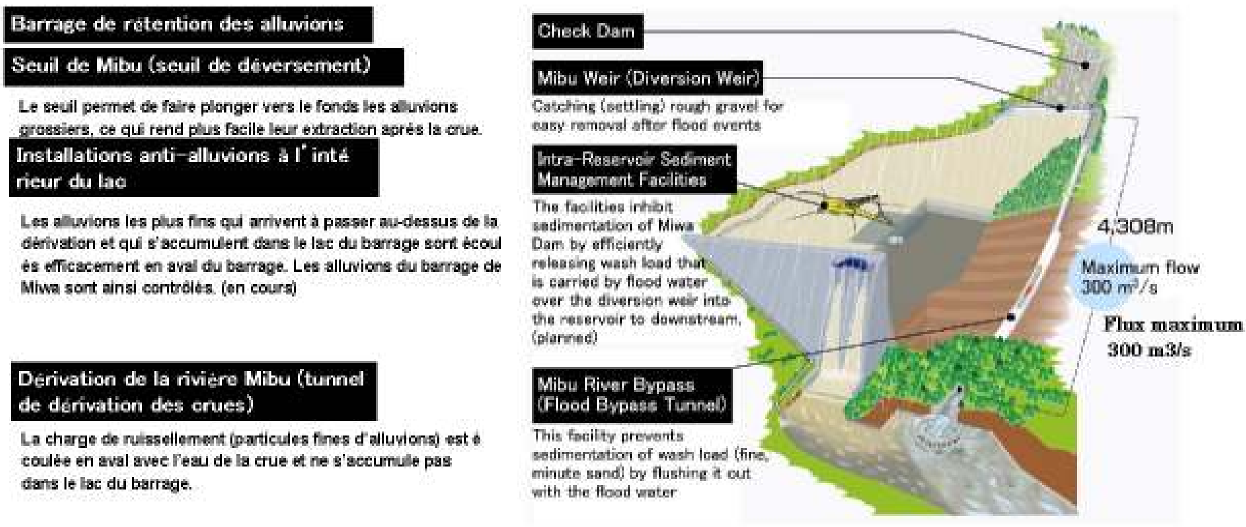


Fig. 4

Image of Miwa Dam Permanent Sediment Management Measure

Illustration des mesures pérennes anti-alluvions du barrage de Miwa

Table 1

Facility Specifications

Caractéristiques des installations

Miwa Dam *Barrage de Miwa*	Type……………….. Concrete gravity dam Height ……………… 69.1 m Catchment area . 311.1 km^2	*Forme………………..* *Barrage en béton renforcé* *Hauteur de la digue ……69.1 m* *Surface de l'eau retenue…….. 311.1 km^2*
Check Dam *Barrage de rétention des alluvions*	Length …………… 144.4 m Height ……………… 10.2 m Sediment storage capacity … 280,000 m^3	*Longeur totale ………144.4 m* *Hauteur …………10.2 m* *Contenance d'alluvions… 280,000 m^3*
Mibu Weir *Seuil de Mibu*	Length …………… 244.5 m Height ……………… 20.5 m Sediment storage capacity …520,000 m^3	*Longeur totale …… …244.5 m* *Hauteur………….. 20.5 m* *Contenance d'alluvions… 520,000 m^3*
Flood Bypass Tunnel *Dérivation de la rivière Mibu*	Length …………… 4,308 m Cross-sectional shape Horse shoe Cross-sectional area 7.8 m^2 Maximum flow ……300 m^3/s	*Longeur totale ………4,308 m* *Forme du tunnel vu en coupe* *En fer à cheval* *Surface de la section… 7.8 m^2* *Capacité maximale de flux ……… 300 m^3/s*

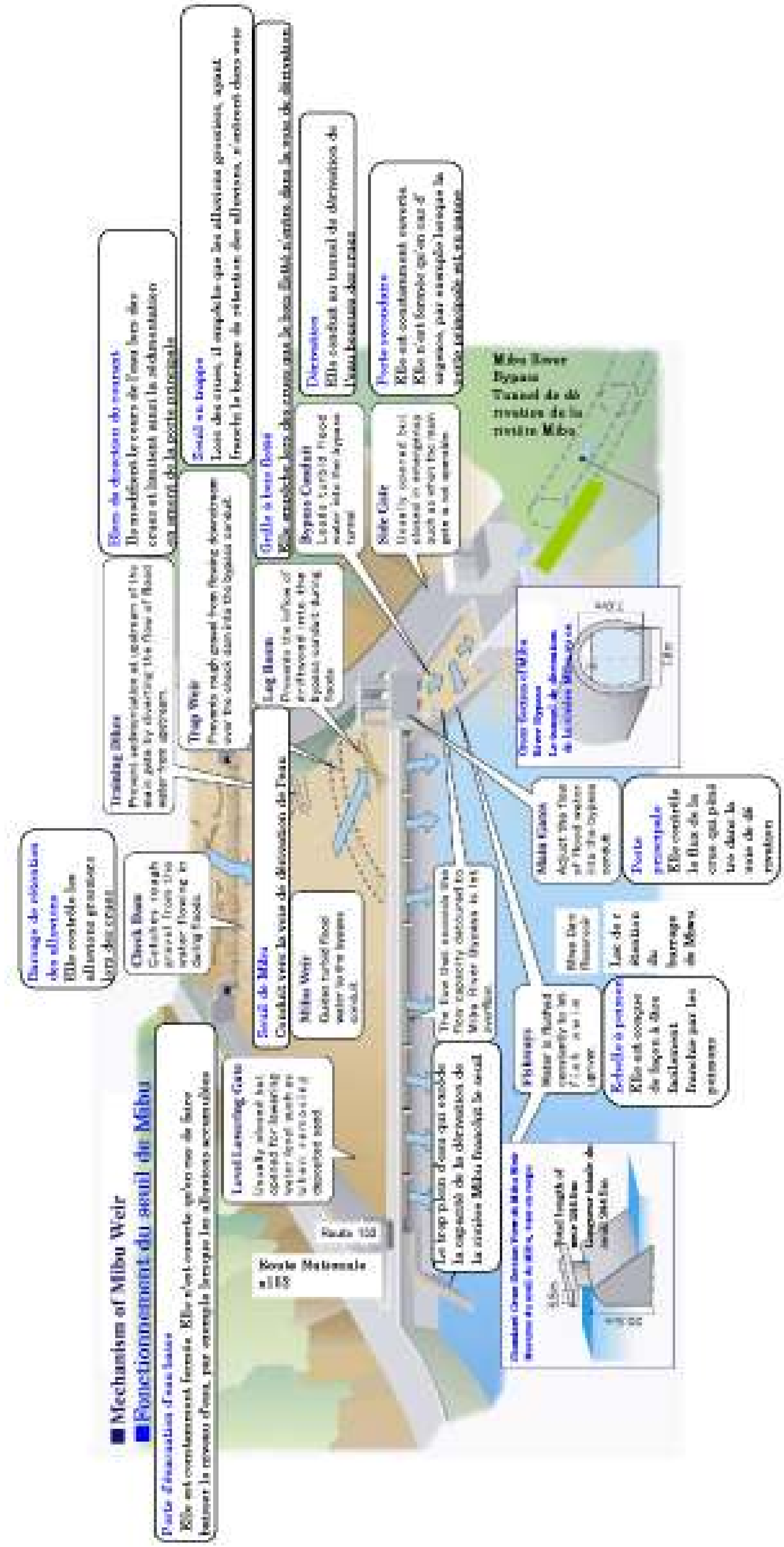


Fig. 5
Mechanism of Permanent Sediment Management Measure
Fonctionnement des mesures pérennes anti-alluvions

4.3. FLOOD BYPASS TUNNEL

4.3.1. Outline of Flood Bypass Tunnel

Before flood bypassing, rough gravel carried in the flood water is trapped at the check dam at first, and finer sand are let flow downstream.

Next, the diversion weir diverts the fine sand (wash load) flowing from the check dam at into the bypass tunnel together with the flood water. On the upstream side of the diversion weir, a trap weir (submerged dike), installed under water, in front of the gate, captures rough objects passing over the check dam to prevent them from flowing into the bypass tunnel. The gate set at the bypass tunnel inlet adjusts the outflow to allow the flood water to flow at maximum of 300 m^3/s.

4.3.2. Sediment Balance Plan (Fig. 6)

Of the annual average of 685,000 m^3 of the sediment flowing into Miwa Dam, an annual average of 160,000m^3 of larger particles (bed load and suspended load) are trapped at the check dam, which has a capacity of about 200,000m^3, and removed by excavation to be effectively utilized as construction materials. In case a large flood occurs and the check dam is up to the capacity, the diversion weir located downstream having a capacity of about 500,000 m^3 prevents the inflow of sand and gravel into Miwa Dam to the possible extent.

Consequently, the 525,000 m^3 of wash load reaching the diversion weir consists only of fine particles, of which an annual average of 399,000 m^3 is discharged through the flood bypass tunnel that has a discharge capacity of 300 m^3/s, an amount that corresponds to the design effluent flow of Miwa Dam. For such water utilization purposes as water level recovery and flood control, an annual average of 126,000 m^3 of wash load flows into the dam's reservoir over the diversion weir when floods occur. Of this, a total of 105,000 m^3 is planned to be discharged, of which 21,000 m^3 is discharged from the spillway on the dam body and 79,000 m^3 by the intra-reservoir sediment management facilities, which will be mentioned later in this paper. Furthermore, the 26,000 m^3 deposited in the reservoir is to be managed by the sediment storage capacity. (Fig. 7 – Photo 4, 5)

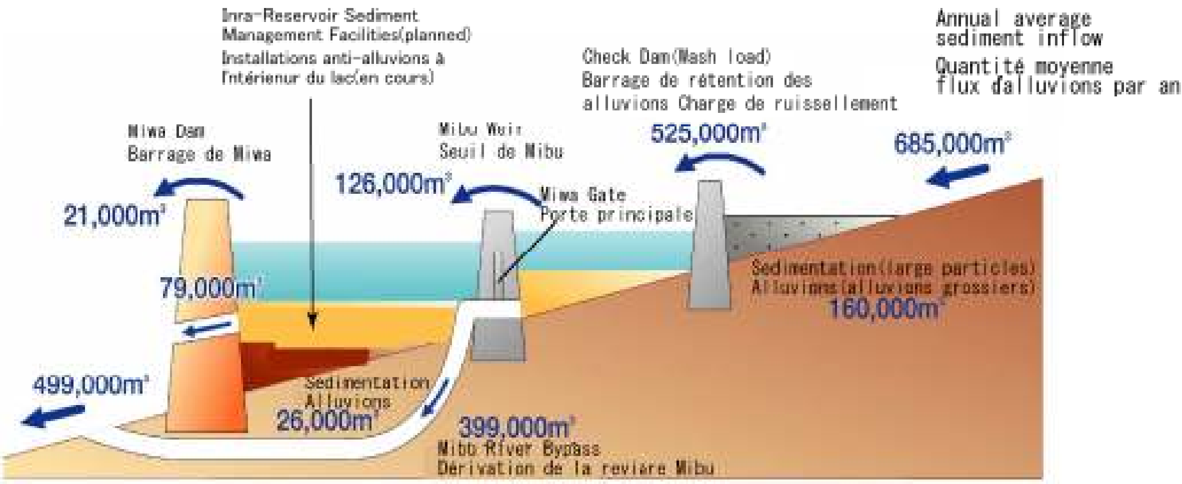


Fig. 6
Schematic of Sediment Management Measures
Illustration des mesures anti-alluvions

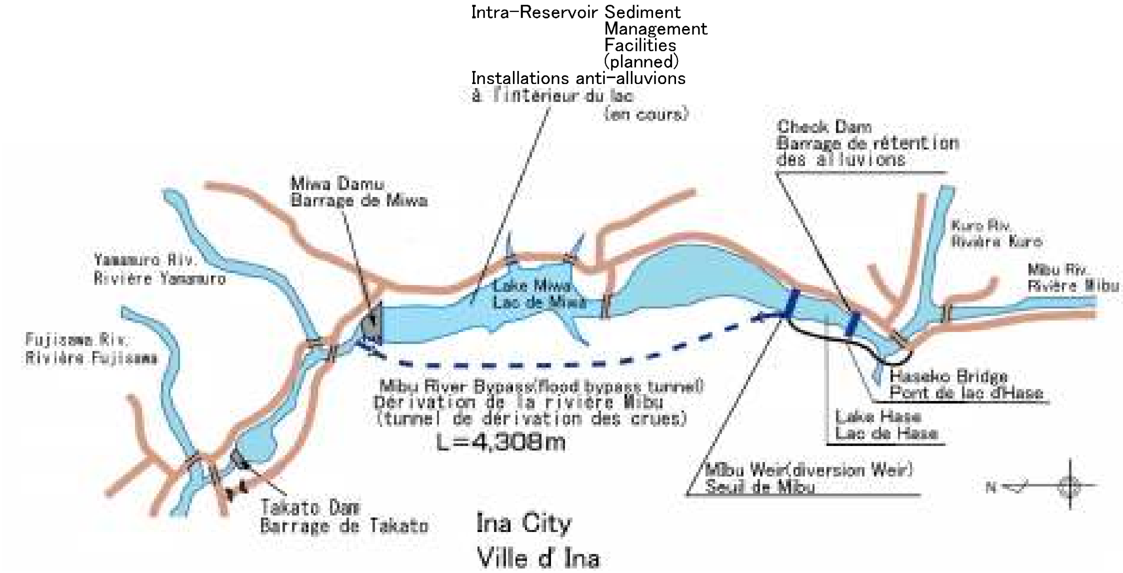


Fig. 7
Location of Facilities
Illustration de l'emplacement des installations

Photo 4
Mibu Weir (diversion weir) and Lake Hase
Seuil de Mibu et Lac de Hase

4.3.3. Operation of Flood Bypass Tunnel (Fig8)

The operation of the flood bypass tunnel will be conducted in coordination with the flood control of Miwa Dam. When the inflow is expected to exceed 100 m^3/s after the water level of Miwa Dam recovers to the normal level, the water is discharged through the bypass at the maximum rate of 300 m^3/s and terminated when the inflow after the peak period goes under 100m^3/s. In this case, setting the power generation discharge as a base line, priority is given to bypass discharge rather than dam discharge as illustrated in Fig. 8.

However, it is necessary to formulate the most effective plan for such operations as commencing of bypass discharge or operation ending flow rate, etc by analyzing and feeding back the monitoring results obtained from trial run.

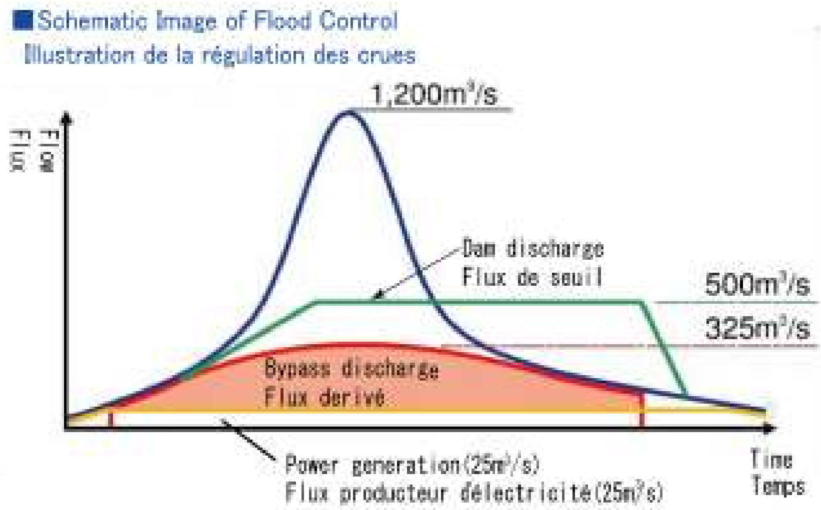


Fig. 8
Image of Flood Control
Illustration de la régulation du flux des crues

Photo 5
Miwa Dam and Tunnel Outlet
Barrage de Miwa et embouchure

4.3.4. Outline of Flood Bypass Tunnel Construction

The flood bypass was constructed according to the following process.

The construction commenced in January 2001 and was completed in March 2005. The tunnel measuring 4,308.1 m in total length, 7 m in height, 7.8 m in width, and 47 m^2 in cross-sectional area was excavated by NATM. From the standpoint of improved working environment, reduced construction period, and enhanced safety conditions, following the VE suggestion provided at the project bid, the excavated material was carried out with a continuous belt conveyor system in stead of the original idea of using dump trucks for transporting the material. This method resulted in higher efficiency and cost reduction. (Photo 6, 7)

For concrete casting of the tunnel floor, in place of conventional pump casting, a slipform system was adopted. This system paved the tunnel with a unit of machines that continuously conducts supply, spreading, compaction, forming, and surface finishing of concrete with higher cement content, which resulted in improved workability and reduction in construction period. (Photo 8)

Photo 6
Belt Conveyor (left) and
Blower Duct (right)
Bande transporteuse (à gauche) et tuyaux de ventilation (à droite)

Photo 7
Removal of Excavated Material
Gravats issues des fouilles

The excavated material carried out from the tunnel was about 280,000 m^3, which was effectively utilized for public construction works (road embankment, land formation materials) of neighboring local municipalities, again reducing the involved cost.

As for reinforcing the tunnel, the section of 110 m downstream from the tunnel's inlet near the reservoir was constructed with reinforced concrete to provide pressure resistance, and the method of consolidation grouting was applied to prevent the loosening of foundation due to blasting excavation as well as to reduce water seepage. Also, curtain grouting was conducted at the point of 100 m downstream from the inlet to reduce water from leaking into the downstream tunnel.

The construction of the diversion weir was commenced in October 2001 and completed in March 2005. About 53,700 m^3 of concrete was cast for the weir body, and about 18,500 m^3 of concrete was used for the bypass conduit that leads flood water to the bypass tunnel. Fishways were provided on the right and left side as an environmentally friendly measure for the river fish. (Photo 9)

Photo 8
Construction by Slipform
La méthode de bétonnage
"coffrage glissant

Photo 9
Construction of Concrete
Diversion Weir
Seuil de dérivation en béton en cours
de construction

In order to allow only wash load into the flood bypass tunnel, a trap weir was installed in an arc of circle in front of the main gates on the upstream side of the diversion weir for trapping large particles. Inside the weir, a log boom was provided to prevent the logs from interrupting gate operation.

As the diversion weir must be constructed inside the reservoir, the construction was carried out during non-flood period from October to March. Nevertheless, reduced-power output compensation was conducted to control the fluctuations of the reservoir's water level. The construction schedule was adjusted in detail form time to time as the construction periods for the diversion weir, its management bridge, and the gate to the weir were overlapping, adding to a possibility of flood even during a non-flood period. As residential houses and restaurants were closely located to the diversion weir, efforts were made in cooperation between the orderer and subcontractor to implement measures against noise, vibration, and dust.

The gate construction was commenced in September 2004 and completed in March 2005. The main gate door divided into 2 blocks and the sub gate door divided into 3 blocks were delivered from the production plant, craned and placed to the specified position, and welded. With regard to the gate opening and closing, bending rack was adopted for the main gates, and motor wire rope winch for the gate from the standpoint of reliability, maintainability, safety, and cost reduction. (Photo 10)

The construction of bypass tunnel outlet involved earthwork volume of 44,800 m^3, cast concrete of 8,200 m^3, and revetment work for 170 m, and was completed in May 2005. The shape and functions of energy dissipaters were designed on the basis of the simulation model of "secondary dam hydraulic jump type energy dissipater" for hydraulic and model testing conducted by the Public Works Research Institute from 1990 to 1992. This method involves energy dissipation of the bypassed water with the apron steps inside the training wall and the secondary dam at the bottom. The water then flows over the secondary dam's sides and the semi-circular-shaped sill to be discharged into Mibu River.(Photo11)

In connection with concrete casting of the diversion weir and the outlet, which was carried out during the winter season, due attention was given to adhere to cold weather concreting requirements, such as curing temperature and form removal timing, so that the quality could be maintained.

Photo 10
Installation of Main Gate Door with Crane
Installation de la porte principale

Photo 11
Construction of Tunnel Outlet
Embouchure en cours de travaux

4.4. INTRA-RESERVOIR SEDIMENT MANAGEMENT FACILITIES

The intra-reservoir sediment management facilities are designed to collect sediment to one place during normal water-level periods, suck it during flood through the sand discharge pipe by using water-level difference, and flush it down to downstream. (Table 2, Fig. 9)

Starting from FY2005, discussions have been held by the Designing VE Panel for considering optimal construction methods including the one jointly developed with private sectors.

The deliberations by the Chubu Regional Development Bureau VE Review Committee approved the setting up of the VE Panel and participation of designing advisors who provide "technical suggestions and advice for optimal methods from the standpoint of life cycle cost, including maintenance and management cost while ensuring the functions and performance." In this way, further reduction of life cycle cost is being promoted against the basic designing.

Table 2
Procedure of Intra-Reservoir Sediment Management
Déroulement des mesures anti-alluvions à l'intérieur du lac

Non-flood period *Période de flux normal*	Collection *Recueil*	Collect sediment *Les alluvions sont recueillis*
	Transport *Déplacement*	Transfer sediment *Les alluvions sont déplacés*
	Piling *Accumulation*	Pile up sediment *Les alluvions sont entreposés provisoirement*
Flood period *Période de crue*	Suction *Aspiration*	Suck up sediment *Les alluvions sont aspirés*
	Discharge *Éjection*	L Discharge to downstream *Les alluvions sont éjectés en aval du barrage*

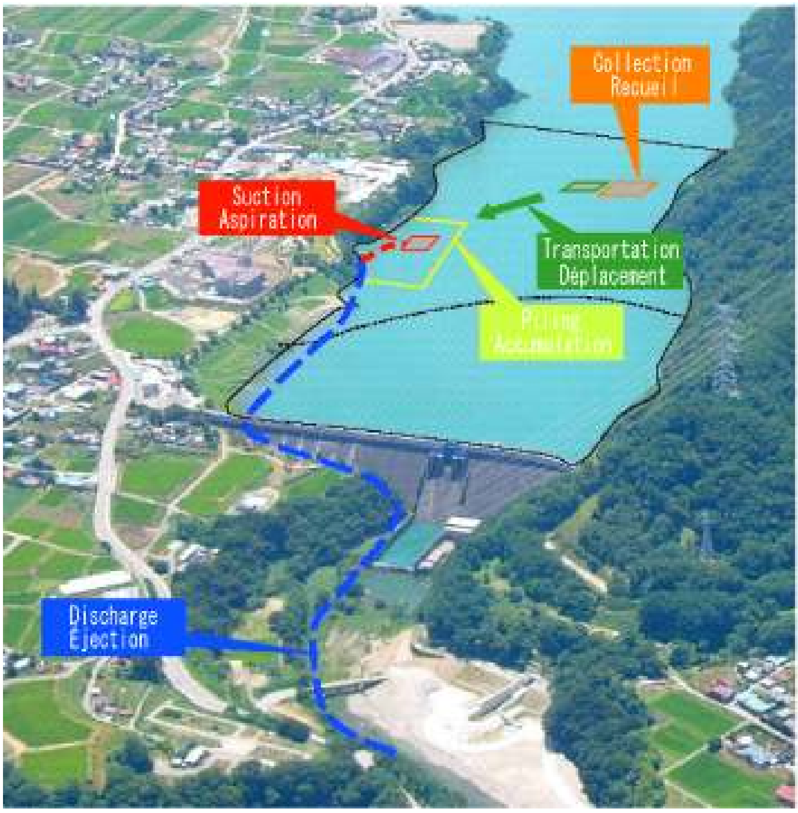


Fig. 9
Image of Intra-Reservoir Sediment Management Facilities
Illustration des installations anti-alluvions à l'intérieur du lac

5. MONITORING OF PERMANENT SEDIMENT MANAGEMENT MEASURES

5.1. MONITORING ITEMS

During the trial run, the following items were checked with a view to verifying the sand discharge effect and evaluating the influence on downstream environments.

5.1.1. Sediment Balance Plan

Evaluation will be carried out on the plan's validity through comparing the measured and estimated results of the following four items:

- Quantity of wash load flowing into Miwa Dam
- Catching status of sand and gravel in the diversion weir and check dam
- Status of sedimentation in the Miwa Dam reservoir
- Status of sedimentation of the Takato Dam reservoir, located downstream of Miwa Dam

5.1.2. Tunnel Structure

The diversion performance of the diversion weir and the status of sedimentation, wear, etc. of the flood bypass tunnel are checked.

5.1.3. Turbidity of Discharge Water

The bypass discharge is expected to let out water with higher turbidity to downstream compared to the conventional gate discharge via the reservoir. On the other hand, it is designed to lessen the turbidity in the reservoir and reduce prolonged turbidity of discharge after the flood. These items are to be evaluated.

5.1.4. Influence to Natural Habitats

The significance on living organisms living in the downstream areas in connection with the change in turbidity of dam discharge.

Approximately a duration of 5 years from the commencement of trial run is planned as the monitoring period, where the frequency or items to be monitored shall be reviewed as needed. Moreover, pre-operation monitoring has been conducted since 2004, a year before the trial run, to have the Chubu Regional Dam and Estuary Barrage Management Follow-Up Committee, organized by the

Chubu Regional Development Bureau, conduct scientific and objective evaluation of the acquired data by comparing it to the monitored results after the trial run.

5.2. OUTLINE OF TRIAL RUN IN FY 2006

In July 2006, heavy rain that caused considerable damages on a nation-wide scale took place, and these left a lot of damaging scars to Lake Suwa and the areas along Tenryu River. Test descharge was carried out by the use of the flood bypass tunnel under trial run from 18th to 20th of July, 2006

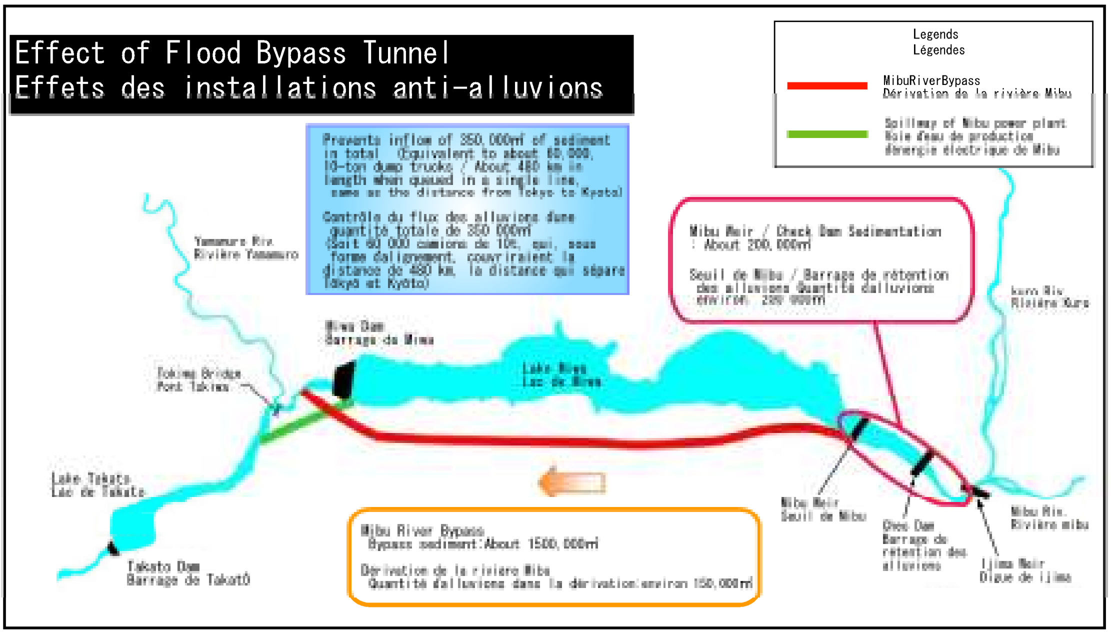
5.2.1. Status of Flood

In the Miwa Dam area, a total area-wide average rainfall of 253.3 mm was recorded from 15:00 on 17th to 18:00 on the 20th in July, 2006, resulting in a flood of maximum inflow of 366 m^3/s. During this rainfall, for about 47 hours from 15:00 on 18th to 14:00 on the 20th, the flood bypass tunnel released up to a maximum of 242 m^3/s.

Of the total inflow of about 33 million m^3, during the test discharge period of 47 hours, about 23 million m^3 was discharged, bypassing approximately 70% of the turbid water from the upstream areas to downstream of the dam.

5.2.2. Effect of Sedimentation Measures(Fig10)

During the test discharge period of 47 hours, about 150,000 m^3 of wash load was bypassed to downstream. In addition, about 200,000 m^3 of gravel and sand was caught at the check dam and diversion weir. Such sand and gravel used to be flowing into the Miwa Dam reservoir before the bypass tunnel was completed, and therefore the inflow of a total of about 350,000 m^3 of sand and gravel was prevented, thus helping sediment volume in the Miwa Dam reduce.



Note) The bypassed sediment was estimated from the SS and flow rate obtained at each measuring point.
La quantité d'alluvions qui est passée est calculée par rapport aux données MES mesurées à chaque emplacementet les données de mesure du flux

Fig. 10
Effect of Flood Bypass Tunnel
Effets des installations anti-alluvions

5.2.3. Status of Tunnel (Photo11)

After the test discharge, no deformation or displacement in the tunnel's lining or outlet as well as in Mibu Weir was observed. No signs of wear were found in the gate as well, and these results confirmed the tunnel's soundness.

Status Inside Mibu River Bypass
(Shortly after discharge on July 20)
Intérieur de la dérivation de la rivière Mibu (le 20 juillet immédiatement après la fin du flux)

Status of Mibu River Bypass Tunnel Outlet
(On August 17, one month after discharge)
Sortie de la dérivation de la rivière Mibu (le 17 août environ un mois après le flux)

Status of Bypass Main Gate
(On August 20, one month after discharge)
Porte principale de la dérivation (le 20 août environ un mois après le flux)

Photo 11
Inside Tunnel, Energy Dissipater, and Main Gate
Intérieur du tunnel, bloc de réduction d'énergie, porte principale

CONCLUSION

The flood bypass tunnel of Miwa Dam was able to detour 150,000 m^3 of sand and gravel to the dam's downstream in the test discharge during the floods in July 2006. The results of this test discharge were reported to the FY 2006 Management Follow-Up Committee for dam facilities, and a favorable evaluation was given regarding verification of the facilities' functions. For this year, the results of test discharges that will be conducted in July and September will be analyzed together, and the results of the sediment balance verification as well as investigation on environmental effect on the downstream areas will be reported for evaluation.

Also, the designing of the intra-reservoir sediment management facilities, an integral supplement to the flood bypass tunnel, will be promoted. This unit of facilities will be designed to further contribute to prevent sediment from accumulating by discharging it through a siphonic principle for flood control related purposes.

As discussed above, the fact that the first flood bypass system for a multi-purpose dam demonstrated its effectiveness can be a valid advance case for other dams facing a similar sedimentation issue. Expectations for utilizing the information provided herein constitute the conclusion of the paper.

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SUMMARY

This paper reports on the outline and effect of the flood bypass tunnel (sand discharge bypass), the first permanent sedimentation measures adopted for multipurpose dams in Japan, and is consisted of the following parts.

1) Background of Miwa Dam redevelopment project and outline of the permanent sedimentation measures

A systematic discussion is given to the outline of Miwa Dam on Mibu River, a tributary of Tenryu River, development of sedimentation in the reservoir, criteria for selecting the flood bypass tunnel and the facility construction project completed in 2005. With regard to the selection criteria of the facility, explanation is given to the project's development taking into consideration that most of the sand and gravel flowing into Miwa Dam is wash load.

2) Operation and effect of the tunnel in flood events that occurred in 2006

As the wash load concentration drastically goes up when the inflow into Miwa Dam exceeds 100m^3/s, the bypass tunnel is operated for floods whose maximum flow rate goes over 100m^3/s. In this paper, the effect of operation in July 2006 is mentioned.

Since its completion in 2005, the tunnel's operations have clearly performed its capability of gravel capture and wash load discharge, and the post-operation inspection showed no wear and damage of the facility, thus demonstrating reliability and soundness of the facility functions. As far as the investigation on environmental

effects on downstream rivers indicates, no adverse effects of sand discharge on natural habitats or sedimentation due to bypass operations have been confirmed.

3) Future development

For the purpose of grasping the operation effect of the bypass tunnel, SS status during operation is continuously observed at Miwa Dam, comprehending its behavior from the beginning to end of flood events.

In the future, with a view to realizing more effective bypass sedimentation discharge, the obtained data will be further analyzed for improvement in the bypass operation methods.

RÉSUMÉ

Cet essai a pour but de décrire et de donner les résultats d'exploitation des installations de dérivation des crues (dérivation des alluvions) qui sont les premières au Japon à proposer pour un barrage à buts multiples des mesures anti-alluvions pérennes. L'exposé se compose des parties suivantes.

1) Détails de la réexploitation du barrage de Miwa et résumé des mesures pérennes anti-alluvions.

Le rapport portera d'abord sur la description du barrage de Miwa sur la rivière Mibu, affluent du fleuve Tenryû, sur les détails des alluvions du lac de rétention d'eau, sur les conditions qui ont conduit au choix d'installation de dérivation des crues et sur les travaux des installations terminées en 2005. En ce qui concerne les raisons qui ont conduit au choix des installations de dérivation des crues, le rapport note qu'elles ont été choisies car plus de la moitié des alluvions qui affluent sur le barrage sont une charge de ruissellement.

2) L'exploitation du barrage durant les crues de 2006 et ses conséquences

La dérivation est utilisée quand le flux d'eau dépasse $100 m^3/s$ car, lorsque le flux d'eau sur le barrage de Miwa dépasse $100 m^3/s$, la densité de la charge de ruissellement augmente brutalement.

Le rapport présente les conclusions de l'exploitation de juillet 2006.

Après la fin des travaux des nouvelles installations de 2005, l'exploitation a permis un véritable contrôle des alluvions et une désédimentation de la charge de ruissellement. Les résultats de l'inspection de l'exploitation du barrage ne révèlent aucune trace d'usure et de détérioration des installations, et démontrent ainsi la sûreté des installations et leur robustesse. Une étude sur l'impact des installations

sur l'environnement en aval de la rivière est en cours mais l'accumulation d'alluvions qui résulte de la dérivation ainsi que l'influence du désalluvionnement sur l'écosystème de la rivière n'ont pas encore été mesurés.

3) Les perspectives

Pour comprendre les effets de la dérivation dans le barrage Miwa, une observation continue des MES (matières en suspension) lors de l'exploitation du barrage est effectuée, englobant les détails du flux de l'eau éjectée tout le long de son parcours.

Afin de parvenir à une éjection des alluvions par dérivation encore plus efficace, une analyse poussée des informations recueillies et une enquête sur l'amélioration des méthodes d'exploitation sont prévues.