DREDGING OF SEDIMENT DEPOSITED IN KURODAKEZAWA RIVER NO. 1 DAM

Katsuo Kimita[1]
Norihide Ishibashi[2]
Takeshi Ono[3]

ABSTRACT

The advance of sedimentation in a reservoir directly impacts the dam's function by reducing reservoir capacity. Moreover sedimentation degenerates the landscape of mountain stream especially in the sightseeing area.

Kurodakezawa River No. 1 Dam, located upstream of the spa town Sounkyo, also had a problem of sedimentation. The dam allowed a small site occupation area of only 260m^2 for dehydrating facilities, in which a conventional filter press to secure dehydrating capacity of 13.5 m^3/h could not be installed. In order to overcome this site condition, Okumura Corporation applied a new dehydrating system with which the slurry containing silt and clay could be dehydrated continuously.

From the viewpoint of the site conditions and the dehydration quantity of 5,400m^3, two horizontal screw presses with diameters of 1,000 and 500mm were selected. The former exhibited an actual dehydrating performance of 10.0 m^3/h and the latter did 3.5 m^3/h. In order to meet the specified cone index (qc=300 kN/m^2 or more) for dehydrated soils, additives to be used in dehydrating process were selected based on the results of advance sampling, and constant control of cone index was applied based on an interrelation between the screw press outlet opening and the dehydrated soils cone index.

INTRODUCTION

The spa town Sounkyo, located at the portal of Daisetsuzan National Park, attracts 2.1 million visitors including 800,000 lodgers in a year. Kurodakezawa River is a narrow river running through the spa town and the size of a drainage basin of the river is about 4.8 km^2. The river, with an averaged grade as steep as 25%, has formed a v-shaped valley after digging down the bed for the past many years. There are many steep and collapsing cliffs made of volcanic tuff along the river and earth washout disasters often occur in the season of heavy rain, like typhoon.

Construction of three of dams was planned and executed previously in order to mitigate washout disaster along the river. Kurodakezawa River No. 1 Dam was built in 1984 as a part of the plan, but since completion of the dam, its reservoir was gradually filled up with soils and rocks delivered down by frequent floods.

[1] Okumura Corporation,Japan, katsuo.kimta@okumuragumi.jp
[2] Okumura Corporation,Japan, norihide.ishibashi@okumuragumi.jp
[3] Okumura Corporation,Japan, takeshi.ono@okumuragumi.jp

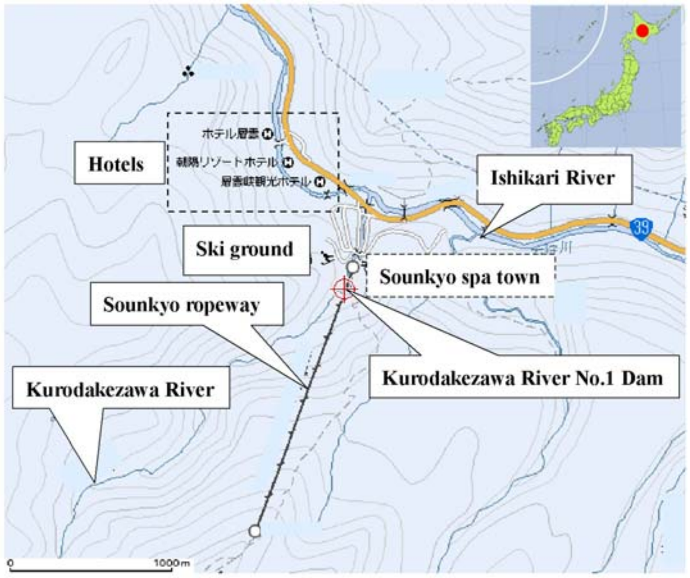

Figure 1. Location Map.

In this project, the sediment in the reservoir, containing much silt and clay, was efficiently removed despite a working space very much limited. Also, the removal works was performed under a strict preservation of water quality of the river.

PROJECT OUTLINE

Purpose of project

Prior to this project, the reservoir of the dam was nearly filled up with sediment of soils and rocks washed out by rains for the past many years. Thickness of the sediment exceeded 10m above the formation level of the reservoir bed.

Top level of the sediment came up to only 1.2m below the emergent outlet of the dam. The purpose of this project was to remove the sediment from the reservoir and recover a proposed capacity to store flooding water and washed material.

Table 1. Outline of Project

Dam owner	Asahikawa Construction Division,Hokkaido Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism (MLIT)		
Project Title	Kurodakezawa River No.1 Dam Sediment Dredging Works in Ishikari River Flood Control Scheme		
Location	Sounkyo Area, Kamikawa-cho, Kamikawa District, Hokkaido Prefecture		
Contract Period	24th July 2007 – 4th March 2008 (Seven and a half months)		
Contractor	Okumura Corporation		
Scope of Works	Earth Work	Excavation (sand and gravels)	24,000 m^3
	Dreging	Dredged soil	2,500 m^3
	Temporary Works	Diversion	496 m

Outline of project

About 60% in volume of the sediment was suitable material to reuse as aggregates of concrete or embankment material. On the other hand, the 55% of the dredged soils was fine particles, including 20% of clay. Conventionally, the dredged soils had been dried under sunshine, or chemically consolidated with cement type additives in use. Natural drying would require a large area to spread the dredged soils, and filter press, the conventional dehydrating equipment, would have a problem of inefficiency caused by intermittent operation

Therefore, we tried a so-called screw press out for dehydration of the dredged soils in this project in order to ensure continuous and efficient dehydration process and compactness in installation. The outline of the project is shown in Table 1.

PROJECT FEATURES

Since the spa town Sounkyo was close to the dam site, preservation of water quality of the river was an important subject. Therefore, the method of works was carefully considered in the light of prevention of muddy water out-flowing from the site to the down stream.

Procedure of works

Soft soil deposit was dealt in two stages i.e. dredging and dehydration. A mechanical combination of a floating backhoe and a pumping verge was chosen as the dredging method, after soil properties, depth, transportation, fluctuating water level, working period, etc., were fully taken into accounts.

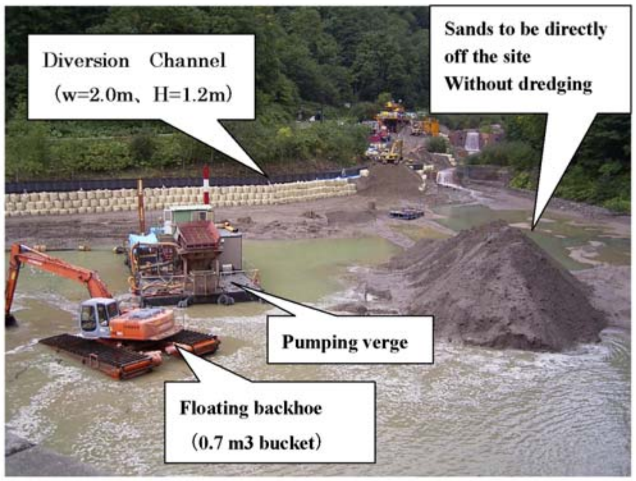

Figure 2. Dredging in Progress.

Also, two number of horizontal type screw press, 1,000mm diameter and 500mm each were selected to achieve continuous operation of dehydration in the limited area as small as 260m^2. Status of the dredging is shown in Figure 2 while the procedure of works and the layout plan of site are shown in Figure 3 and Figure 4 respectively.

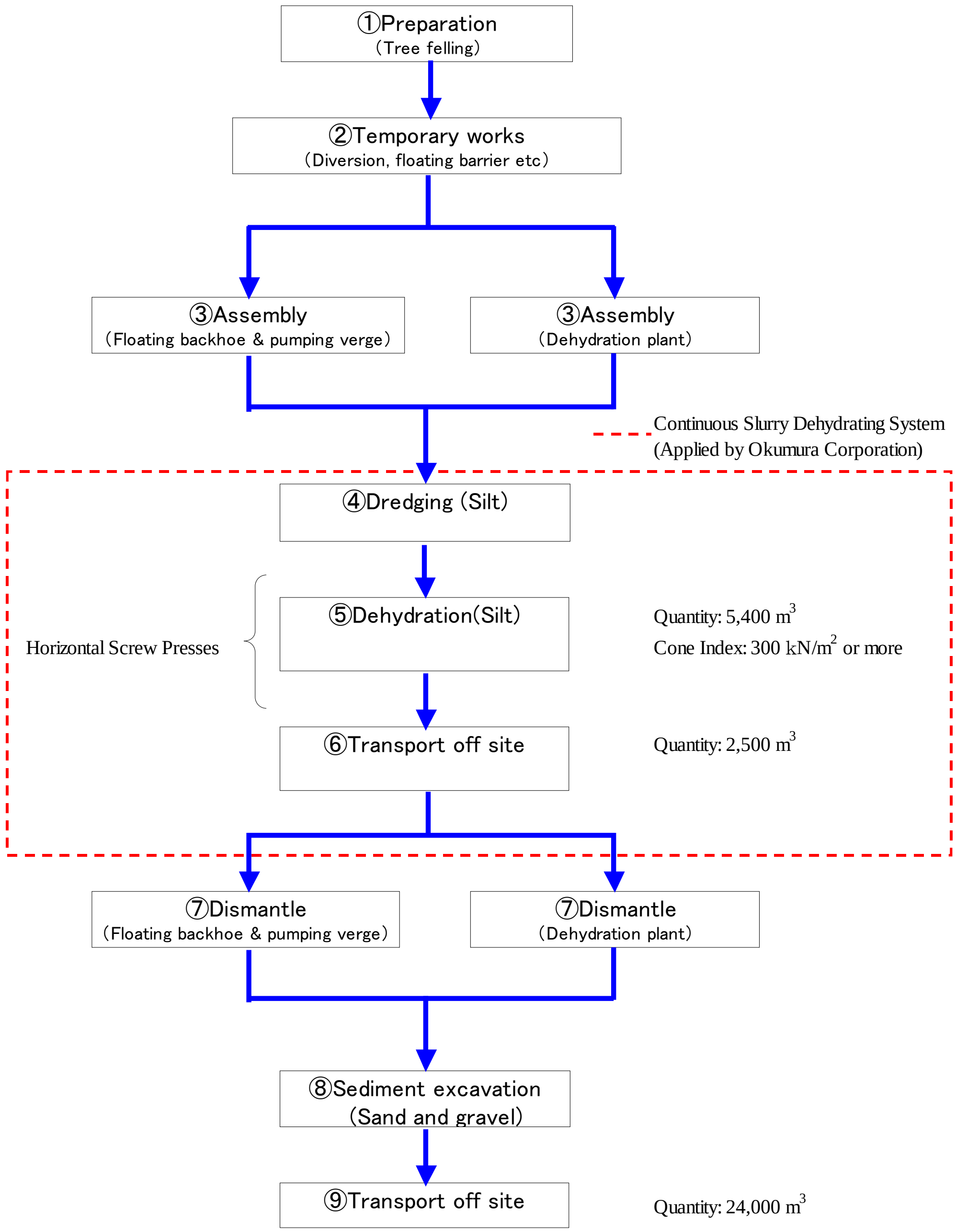

Figure 3. Procedures of Works.

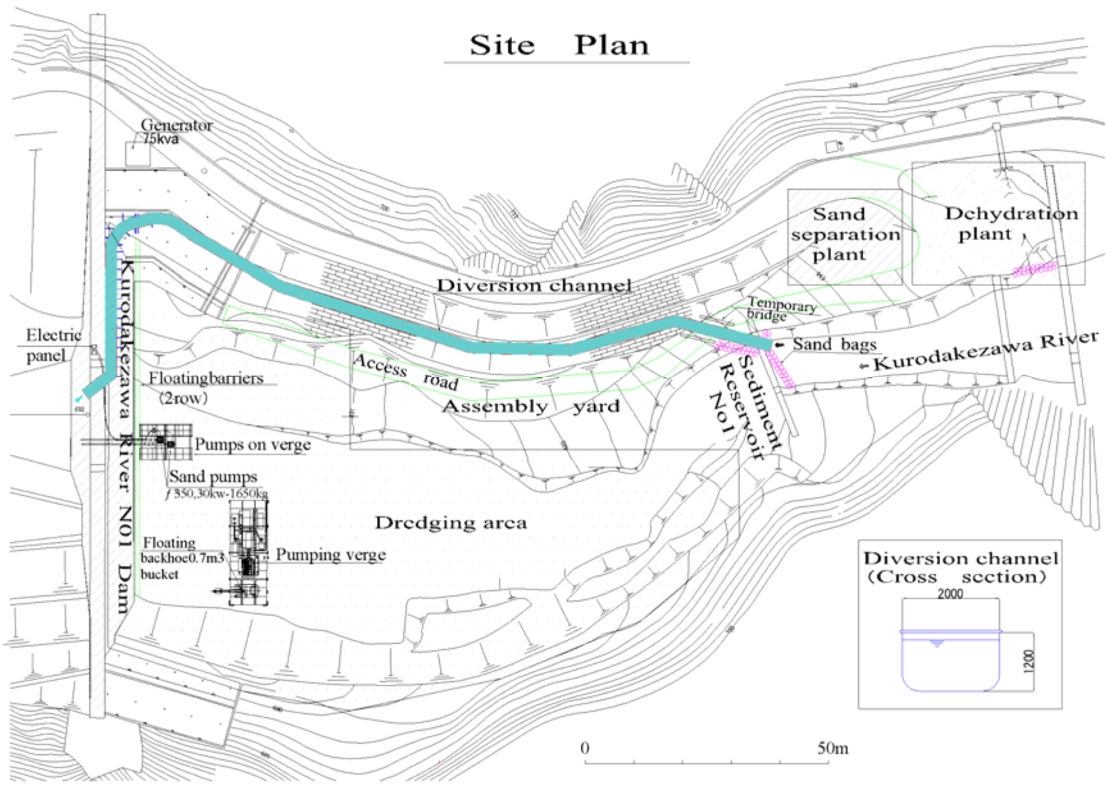

Figure 4. Site Plan.

Method of construction

Dredging. As the water in the reservoir was very shallow with depth only about 1.0 m, the floating backhoe (equipped with extra wide caterpillars) was used to excavate soft soils and feed it to the pumping verge. Then, the soft soils were pumped through a pipeline to the dehydration plant. Status of the reservoir and the dredging work by means of the floating backhoe and the pumping verge is illustrated in Figure 5.

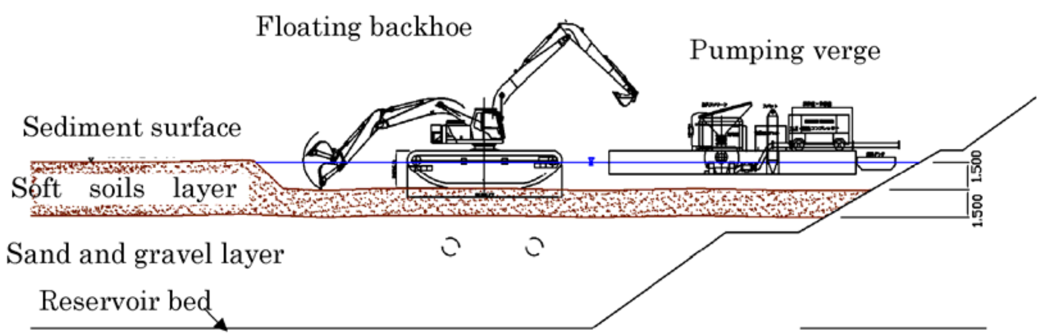

Figure 5. Dredging Arrangement.

Dehydration. The soft soils dredged and pumped, as the mixture of the slurry, were primarily processed through sand separation screens. Gravels, coarse sand and foreign materials (wood chips etc) were separated at the vibration screen from the slurry, and so was fine sand at the fine mesh separator. These separation screens are viewed in Figure 6.

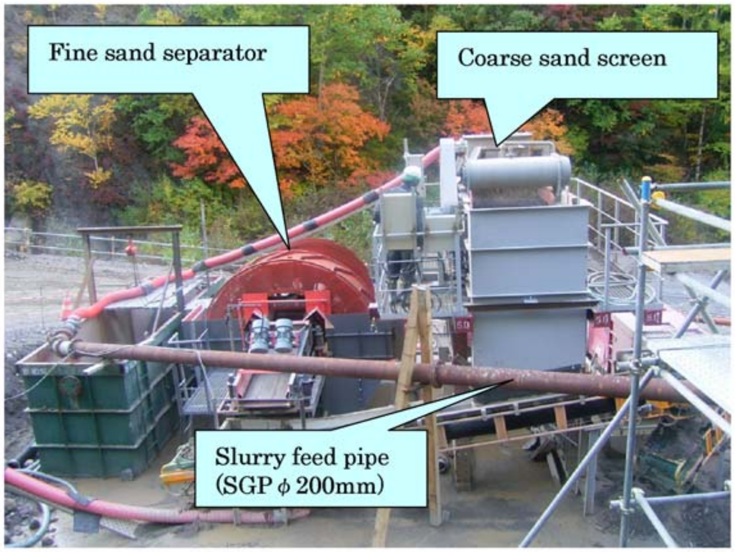

Figure 6. Sand Separation (Prior to Dehydration).

The polymeric flocculant (anion-cation type) and the by-acting material (fly ash) were added into the slurry at the flocculation tank. The slurry was stirred evenly in the tank and was finally dehydrated by the screw presses to meet the required strength (qc=300 kN/m^2 or more) in a continuous operation.

Figure 7 shows the separation screens in operation and the separated material, and Figure 8 shows the layout plan of sand separation and dehydration plant and Figure 9 shows general view of the dehydration plant.

Vibration screen for coarse sand   Fine mesh screen for fine sand

Figure 7. Sand Separators in Operation.

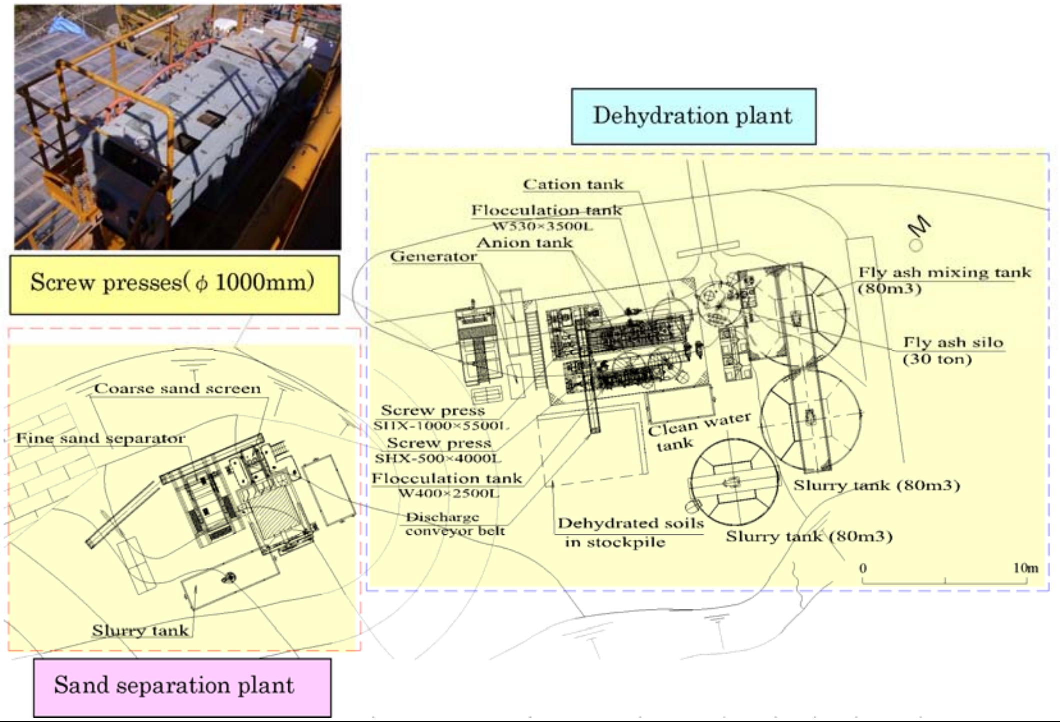

Figure 8. Sand Separation and Dehydration Plant.

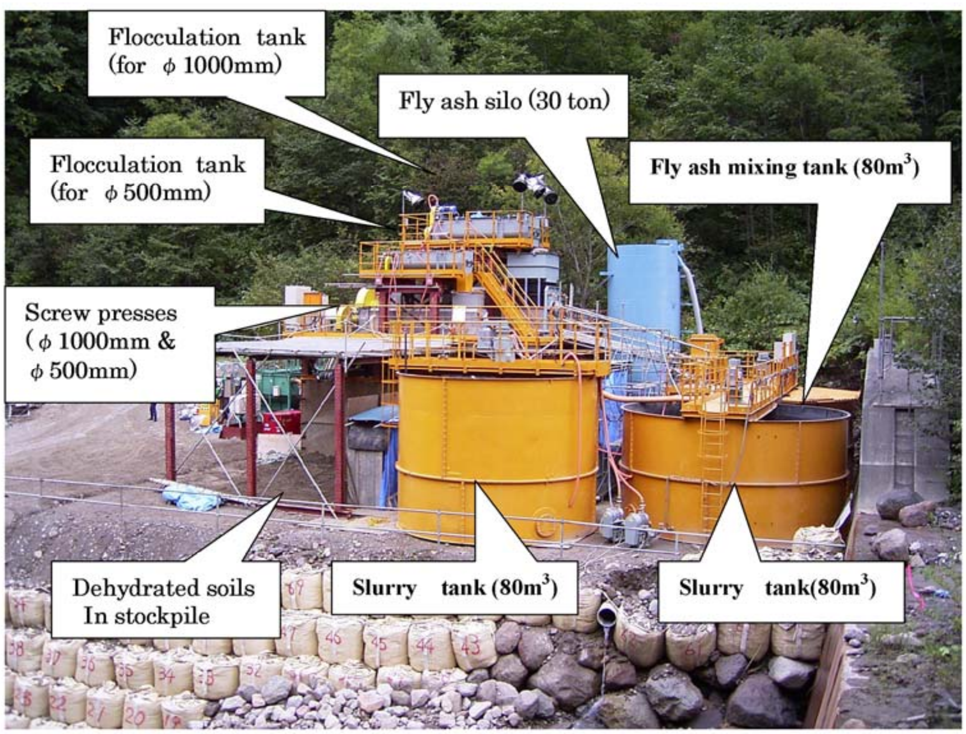

Figure 9. View of Dehydration Plant.

Dehydration Requirement

The required strength that the dehydrated soils should have was the cone index of 300 kN/m^2 or more in conformity with requirement of the designated disposal area. In case of the dehydration by means of the screw press, the strength of the dehydrated soils increases as the rotation speed of the screw is lowered. That is because the slower rotation takes more time for the soils to move forward in the screw press, and eventually more water is squeezed out of the soils. Therefore, in this project, the required strength of the dehydrated soils was achieved by controlling the rotational speed of the screw. Figure 10 shows the status of the dehydrated soils.

Figure 10. Status of Dehydrated Soils.

DEHYDRATION SYSTEM

System Features

The dehydration system comprising the screw press etc is featured as follows;

(1) Use of the screw press minimizes an area required for installation, reducing 25% and 90% in comparison with dehydration by filter press and natural drying respectively, which can be used in the very limited working space.

(2) Continuous operation is possible. Cost for dehydration process is saved owing to improvement in mechanical efficiency and manpower saving, comparing with filter press.

(3) The screw press is applicable to a wide variety of soils, when the primary (sand) separation plant is suitably selected.

(4) Structure of the screw press is simple enough to dispense much of routine adjustment or checking, and thus maintenance is very easy.

(5) Cost for maintenance is low because the rotational speed of the screw is low (about 0.3 rpm for 1,000mm in diameter), and consumables at the driving part are minimum.

(6) Adverse impact to the environment due to noise or vibration is utmost mitigated as the rotational speed of the screw is low.

(7) Electrical consumption is reduced by 15% comparing with other dehydrating plants.

Outline of screw press

Mechanism of dehydration in the screw press is illustrated in Figure 11. After the polymer flocculant is added, the slurry containing dredged soils is fed into the mouth of the screw press. The slurry is slowly moved forward corresponding rotation of the screw. As the clearance between the cylindrical screen and the screw shaft of corn shape becomes narrower, the slurry is more pressed, and the water is more squeezed from the slurry and soils. At the outlet of the screw press, a corn ring was fitted. The ring was pneumatically pressed against the dehydrated soils while the dehydrated soils were discharged pushing the ring back. The water was squeezed out through the cylindrical screen.

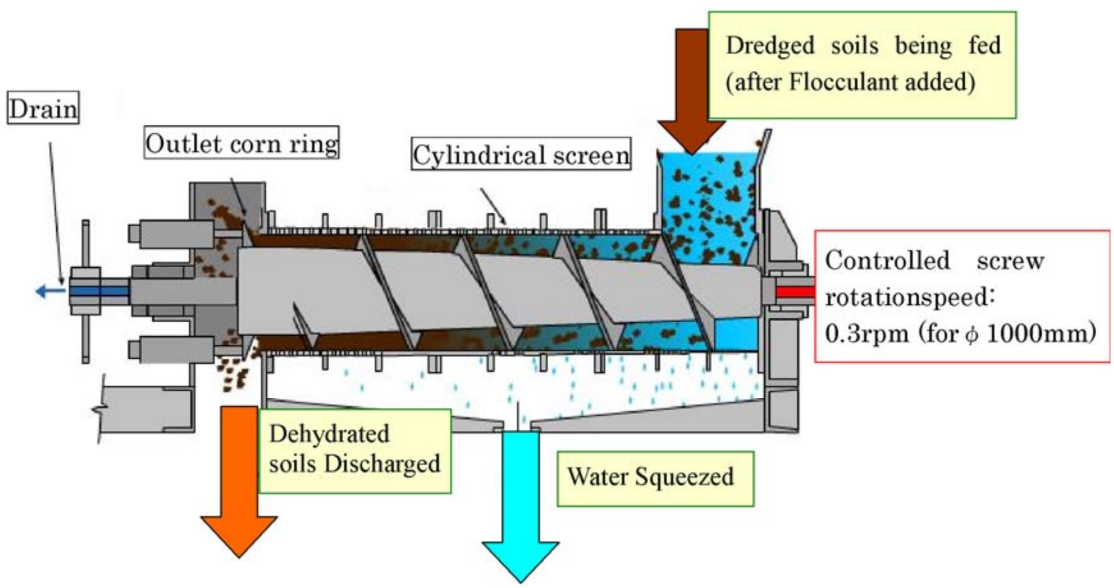

Figure 11. Dehydration (Screw Press) Mechanism.

Dehydration Control System

Soils of construction debris are generally classified in Japan, along with required cone indexes. The cone index should be achieved in accordance with a classification that each project designates.

The length with which the dehydrated soils push the outlet ring back is defined as an outlet opening. It is known that there is an interrelation between the outlet opening of individual screw press and the cone index of the dehydrated soils, as shown in Figure 12.

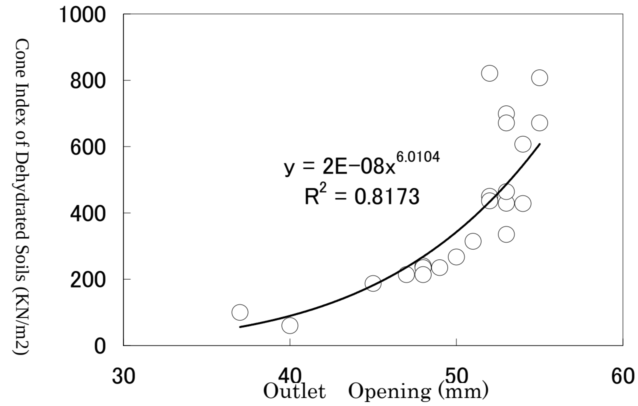

Figure 12. Interrelation of Outlet Opening – Cone Index.

In the control system for this project, being based on such outlet opening-cone index interrelation, the target outlet opening was pre-determined, and the rotational speed of the screw press was controlled to maintain the target opening so that the required cone index might be achieved. The control system achieved continuous dehydration process and saved manpower and cost, otherwise frequent cone test would be required to interfere dehydrating operation each time.

CONCLUSIONS

In recent years, dam sediment has become a serious issue to be dealt urgently as it causes functional disorder of dams all over Japan. Conventional treatment method, either dry up by sunshine or filter press treatment is not free from problem. The former needs a large area to spread dredged sediment under sunshine while the latter finds difficulty in continuity of dehydrating operation.

In a technical circumstance aforesaid, the dredged sediment containing much silt and clay was successfully treated for a short term of seven and half months in this project, only with a very limited working space 260m^2 available. At the same time, the works was performed and completed while the water quality of Kurodakezawa River was well preserved.

The dehydration technology proven in this project to be efficiency will be widely applied for dehydration of not only dam sediment but also other soft soils or mud of construction debris as eco-friendly attitude is more expected in the construction industry than ever before.