Key Issues: **15- Others**

Climatic Zone:
Cf : Temperate humid climate

Subjects:
- Recycling

Effects:
- Composting of construction waste

Project Name: Shin-Shimodaira and Shin-Koara Power Plants
Country: Niigata Prefecture, Japan (Asia) (N37˚55′, E139˚02′)

Implementing Party & Period
- Project: Tousei Kougyou Co., Inc.
1999 (Commencement of construction) -
- Good Practice: Tousei Kougyou Co., Inc.
1999 - 2002

Key Words:
Construction waste, composting and recycling

Abstract:
For the purpose of ensuring the availability of construction yard, an attempt was made to compost and improve effective use of wooden waste such as cut and uprooted trees as well as construction waste such as dehydrated sludge cake generated from the muddy water treatment system.

1. Outline of the Project

Tousei Kougyou Co., Inc., an affiliate of Tohoku Electric Power Co., Inc. is a wholesaler of electricity. The Shin-shimodaira Power Plant and the Shin-koara Power Plant are respectively the 9th and 10th power plants developed by Tousei Kougyou Co., Inc. Tousei Kougyou took over from Tohoku Electric Power power plant redevelopment that involved the closing down of the Shimodaira and Koara power plants.

These power plants, located in Kanose-machi, Higashi-kanbara Gun, Niigata Prefecture as shown in Fig.-1, are hydroelectric power plants, which use abundant water resources from the Sanekawa River, a part of the Aganogawa River system (classified as a Class A river) that originates from the Iide Mountain Range of 2,100+ meters.

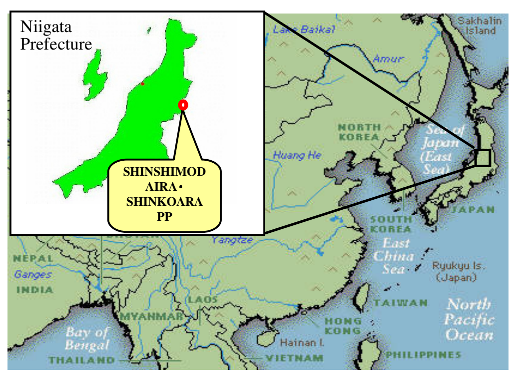

Fig.-1 Locations of Power Plants

Power source development has long been promoted along the Sanekawa River, which is a part of the Aganogawa River system. Four power plants have been developed up until now. With the exception of the most upstream Sanekawa Power Plant (where operations commenced in November 1992), the other three power plants – Shin-shimodaira, Akakura and Koara Power Plants – started their operations in the 1920's.

The comparison of cost effectiveness between prolonged use of existing facilities and redevelopment, therefore, took into consideration the facts that facilities have deteriorated over some 70 years since the commencement of operations and that the facility utilization factors are high, around 80%. Based on the conclusion reached through the comparison that it is more advantageous, from a general point of view, to increase the scale of the Shin-shimodaira and Koara Power Plants and reduce the power generation capacity of the Akakura Power Plant by means of dismantling facilities (from the maximum output of 2,510 kW down to 910 kW), this development project was undertaken (Table-1).

The Shin-shimodaira Power Plant development project is aimed at generating a maximum of 17,300 kW of electric power, by taking in water at the rate of a maximum of 9.50 m^3/s (a maximum of 3.50 m^3/s from the existing Shin-shimodaira Intake Dam and a maximum of 6.00 m^3/s from the floodway of the upstream Sanekawa Power Plant run by Tohoku Electric Power Co., Inc.), leading the water through a headrace of a total length of 5.0 km and then creating an effective head of 221.50 m. The water after power generation will directly be released through the floodway to the headrace of the downstream Shin-koara Power Plant (Fig.-2).

Fig.-2 Shin-shimodaira Power Plant

The Shin-koara Power Plant development project is, on the other hand, aimed at generating a maximum of 11,300 kW of electric power, by taking in water at the rate of a maximum of 17.0 m^3/s (a maximum of 7.50 m^3/s from the existing Koara Dam and a maximum of 9.50 m^3/s from the upstream Shin-shimodaira Power Plant), leading the water through a headrace of a total length of 4.5 km and then creating an effective head of 77.10 m. The water after power generation will be released through the floodway to the main Sanekawa River.

The construction of the two power plants was started in August 1999, with operations scheduled to commence in June 2002 (construction already completed) at the Shin-shimodaira Power Plant and in January 2003 at the Shin-koara Power Plant.

Table-1 Power Generation Specifications

Item	Unit	Existing power plants		New power plants	
		Shimodaira	Koara	Shin-shimodaira	Shin-koara
River system		Sanekawa River (Aganogawa River system)			
Catchment area	km^2	44.0	112.6	44.0	100.1
Power generation method		Run-off river type power generation			
Maximum output	kW	3,830	3,700	17,300	11,000
Maximum discharge	m^3/s	3.34	7.79	9.50	17.0
Effective head	m	153.420	65.744	221.500	77.100
Annual electric generation	MWh	25,301	25, 873	79,582	49,848

2. Features of the Project Area

The Sanekawa River, a part of the Aganogawa River system, located in northeast Kanose-machi, Higashi-kanbara Gun, Niigata Prefecture, is a steep river with a total channel length of about 23 km and catchment area of 122 km^2. The river originates in the south slope of Mt. Dainichi-dake (2,128 m in elevation) located in the south end of the Iide Mountain Range and as shown in Fig.-3 flows southwestwards, creating V-shaped deep valleys all the way.

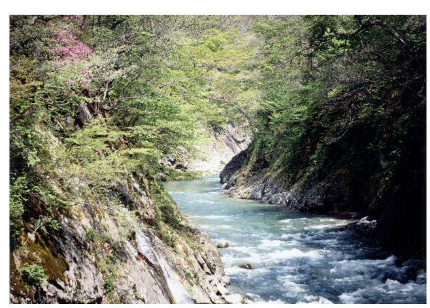

Fig.-3 Sanekawa River Valley

With regard to the natural landscape around the project area, the Sanekawa Valley created by the Sanekawa River was

selected as one of the 100 most spectacular landscapes in Niigata in the "Spectacular Natural landscape in Japan" (published by Environment Agency in 1989), the "3rd Basic Survey of Natural Environment Protection – Natural Environment Information Map in Niigata Prefecture" (published by Environment Agency in 1989) and the "Tourist Guidebook of Niigata Prefecture" (published by Niigata Prefecture in 1990).
The natural parks around the project area preserve a rich natural environment; for example, the upstream river basin of the Sanekawa River are designated as the Bandai-asahi National Park (Third class special zone) and the area along the downstream river basin Sanekawa River is designed as the Prefectural Aganogawa River Line Natural Park (Third class special zone).
The Sanekawa River basin encompasses upstream river basin national forests of Japanese beeches and oaks (grosseserrata) and downstream river basin privately-owned forests with mainly Japanese oaks (Quercus serrata). These downstream forests, although held under private ownership, are designated as Niigata Prefecture's regional foresting project area, for the purposes of protecting forests from overdevelopment and ensuring proper use of forested land. Various measures are, therefore, carried out during power source development, including the protection of the forest environment by means of preserving or creating forests.

3. Examination of the Waste Treatment Method

The new construction of the Shin-shimodaira and Shin-koara Power Plants began in August 1999 with the preparatory work that included tree cutting. Then, the construction went into full swing with the work in areas located in national and protection forest area in October 1999.
Civil works under this project mainly consisted of river and tunnel works. The muddy water generated from excavation and concreting works was processed by the simple muddy water processing plant into dehydrated sludge cakes.
These dehydrated sludge cakes must be processed in accordance with the provisions of the Waste Disposal and Public Cleaning Law that went into effect in 1970. Additionally, Ministry of Health and Welfare issued the Guideline for Construction Waste Treatment in March 1999 to make mandatory the proper treatment of construction waste, in view of increased awareness in recent years regarding the need for environmental protection to halt environmental destruction, for example, caused by unlawful waste dumping, and in order to promote recycling.
Recent social conditions have also made it increasingly more difficult to set up a new terminal treatment plant for industrial waste, and the terminal treatment plants currently in operation are reaching the limit of their capacity.
Under these conditions, this project included a program to recycle construction waste by means of first pulverizing wooden waste, and then, mixing it with dehydrated sludge cakes for composting, since the project was estimated to generate wooden waste (approx.10,000 m^3) such as cut and uprooted trees as a result of tree removal to ensure the availability of construction yard as well as dehydrated sludge cakes (approx. 5,000 m^3) from the muddy water treatment system.
Wooden waste, one of the two types of construction waste discussed here, does not fall under the category of industrial waste since it is stipulated in Ministry of Health and Welfare Ministry notification -- Handling of uprooted and cut trees and branches resulting from civil works, new construction and removal – issued in November 1999 that wooden waste must be naturally reduced to surface soil.
On the other hand, dehydrated sludge cakes must be first intermediately processed by the muddy water processing plant. Then, the sludge generated from the intermediate treatment plant must be treated as construction sludge (industrial waste) under the application of the Waste Disposal and Public Cleaning Law.
Three possible methods for treating dehydrated sludge cakes shown below were examined.

Treatment method

Composting:	Conversion of sludge into materials with commercial value (construction materials or compost).
Transporting to the treatment plant:	Transportation of sludge to the controlled terminal treatment plant for disposal.
Disposing at the soil dumping site:	Disposal of sludge at the soil dumping site after obtaining approval for final disposal (granulation, solidification and burial of sludge).

Table-2 Examination of the treatment method

Treatment method	Economic performance	Advantage	Problem
Composting	◎	Composted sludge can be used as backfilling material when returning the timberland leased for temporary storage of equipment.	A large stockyard is needed.
Transporting to the treatment plant	△	No management efforts are needed.	Only few number of treatment plants within a few thousand meters means long distances of transportation.
Disposing at the soil dumping site	○	The disposal of sludge at the soil dumping site means easy transportation.	At least a year is required to obtain approval and the management of the site is mandatory after completion.

As the result of comparison, the composting method was selected as it proved most ideal from a general point of view.
Incidentally, the composting method using sludge cakes is quite unique; other similar examples are rarely found in Japan.

4. Overview of the Composting Method

Since two different materials are involved in the composting process, two separate work processes are required.
First, the composting process No. 1 includes the pulverization of wooden waste into chips and the adding of the microbial soil conditioner to prepare bark compost.
Next, the composting process No. 2 includes the mixing and blending of dehydrated sludge cakes as well as a fermentation promoter (fermented fowl droppings) with the bark compost produced through the composting process No. 1 for final composting. The following steps must be performed during each process.

Composting process No. 1

1) Perform the first pulverization of uprooted trees (Fig.-4) using a cutter/pulverizer designed for wood in order to pulverize trees into sizes that can be thrown into the wood pulverizer used for the second pulverization and remove stones embedded in uprooted trees.
2) Throw trees that underwent the first pulverization into the wood pulverizer and perform the second pulverization to reduce them to 38 mm chips (Fig.-5). Add the microbial soil conditioner at the same time to accelerate the fermentation of the chips.

Comp
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Fig.-4 First Pulverization

Fig.-5 Second Pulverization

ost

project site. The composting process No. 2 was started in November 2000 and completed in August 2002 when dehydrated sludge cakes were no longer produced. The laying and leveling of compost is scheduled to finish in November 2002.

5. Post Composting Confirmation

A component analysis shown in Table-3 and a germination test shown in Table-4 were performed in order to check whether the compost produced through the two composting processes can be used as the soil that covers the land to be returned.

If using the bark compost quality criteria for the component analysis, the compost produced has yet to reach the required level of maturity. However, the fact that it comes close to the required level of nutritive salts (N, P and K) seems to suggest that the compost can be used for practical applications.

The comparison between the composting process No. 1 and No. 2 suggests that the mixing of dehydrated sludge cakes increased pH, and metal and carbon contents, particularly the aluminum content. Nonetheless, since it is still smaller than the 71,000 ppm aluminum content in average soil, it is not likely to cause problems. The compost produced contains much the same level of nutritive salts as average soil.

A germination test was carried out using Chinese cabbage because it is important that plants normally grow on the compost being processed through the composing process No. 2.

Test results are shown in Table-4 and 5 and Fig.-7. Although the compost being processed through the composting process No. 2 has a slightly higher pH than desired, the fact that it has an electric conductivity of 0.14 mS/c m seems to suggest that there is virtually no influence on germination.

The germination rate is much the same when using the compost being processed through the composting process No. 2 and mountain soil. The germination rate three days after seeding was high on the mixture of the compost being processed through the composting process No. 2 and mountain soil, presumably because of the fertilizing elements contained in the compost and the soil improvement effect from mixing and blending.

Table-3 Analysis Results

Item	Unit	[Composting process No. 1] The microbial soil conditioner has not been added after pulverization (12/5).	[Composting process No. 1] Two months after adding the microbial soil conditioner (12/7).	[Composting process No. 2] Eight months after mixing and blending sludge cakes (13/7).	Bark compost quality criteria (1st class)
1. Moisture	%	7.5	63.5	45.2	In the neighbor-hood of 60%
2. Heat loss	%	86.2	93.3	22.7	
3. pH		6.4	6.1	8.0	6.0 ～ 7.5

Table-4 Germination Test

Sample / Number of days passed after seeding		Number of germinated seeds (Number of seeds planted: 15) 3 days	6 days	8 days	10 days	Germination rate %
When only using mountain soil	n1	8	15	15	15	100
	n2	9	15	15	15	100
1:10 Compost being processed through the composting process No. 2	n1	13	15	15	15	100
	n2	11	15	15	15	100
1:2 Compost being processed through the composting process No. 2	n1	10	15	15	15	100
	n2	11	13	13	13	87
When only using the compost being processed through the composting process No. 2	n1	11	15	15	15	100
	n2	9	14	14	14	93

6. Effect of Using Compost

Final disposal at the controlled terminal treatment plant or at the soil dumping site is expensive in terms of processing and transportation cost, while final disposal by means of composting requires about 1/10 of the cost (amount processed = approx. 500 m^3). Through composting, construction waste was also successfully recycled into planting soil that covers (30 to 50 cm deep) the timberland for temporary storage of equipment and the soil dumping site, both of which must be returned to their owners.

Fig.-7 Germination 10 Days after Seeding

7. Reasons for Success

To treat muddy water from civil works, it was originally planned to carry in and dispose of deposited, dehydrated sludge cakes at the soil dumping site. However, the information obtained from the consultation with organizations concerned (public health centers) in an early stage prior to construction led to the introduction of the composting process.

Much effort was also devoted to ensure coordination with local communities; for example, a briefing on this project was held for local communities. Discussions were also repeatedly held, particularly regarding how the lands leased from landowners for temporary storage of equipment should be returned in order to prevent conflicts with local communities from arising in the future.

This project, apart from promoting composting, includes a beetle-breeding program, as shown in Fig.-8, using cut trees and compost to help community revitalization, taking advantage of the local communities natural environment. Our campaign to donate beetles to local communities elementary schools and town tourist facilities evoked a large response; reporters from local communities media rushed to cover the news.

Fig.-8 Breeding of Beetles

8. Outside Comments

1) Niigata Daily News (June 28, 2001)
   The employees of Tousei Kougyou Co., Inc., now undertaking power plant construction in Kanose-machi, Higashi-kanbara Gun, Niigata Prefecture, are breeding beetles using cut trees and compost, to help community revitalization efforts. These beetles are handed to visitors to the town.

9. Further Information

9.1 References

1) Chiyoshi SASAKI, Ryo HOSOGOE and Kazunori WATANABE: Overview of the Redevelopment Plan for the Shin-shimodaira and Shin-koara Power Plants, Japan Electric Power Civil Engineering Association, March 2000
2) Chiyoshi SASAKI and Kazunori WATANABE: Composting of Construction Waste, Japan Electric Power Civil Engineering Association, November 2001

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