Treatment of disaster waste generated by the Great East Japan Earthquake

-Treatment of disaster waste by member corporations of the Japan Federation of Construction Contractors-

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ABSTRACT

As a result of The Great East Japan Earthquake, approximately 28 million tons of disaster wastes (such as disaster debris and tsunami deposits) were generated in the three prefectures of Iwate, Miyagi, and Fukushima, mainly due to the tsunami. The waste treatment on this massive scale would normally take more than a decade. For the local recovery and reconstruction, disaster waste treatment was the first step, and its early treatment was essential. Two months after the disaster, the government prepared a master plan for completing the treatment by the end of March 2014, approximately three years after the earthquake, focusing on recycling of the waste. Due to the enormous amount of waste and its complicated physical properties, disaster waste treatment posed a number of problems. However, the construction industry and related parties worked on the task with a sense of mission, completing the treatment in Iwate and Miyagi prefectures by the end of March 2014, as specified by the national government, and achieving a recycling ratio of nearly 90% based on thorough recycling and reuse. Materials recycled through treatment were used for embankment and backfilling, etc. in public reconstruction projects.

Keywords: Great East Japan Earthquake, disaster waste treatment, recycling, reconstruction materials

1 INTRODUCTION

As a result of The Great East Japan Earthquake, an enormous amount of disaster wastes were generated in municipalities along the coast of the three prefectures affected: approximately 5.84 million tons in Iwate, 18.7 million tons in Miyagi, and 3.49 million tons in Fukushima prefectures. Due to the huge amount of waste and its complicated physical properties, disaster waste treatment posed a number of problems. It was therefore necessary for the construction industry to devote its full range of skills, experience, and management capabilities to undertake this difficult task. In Iwate and Miyagi prefectures, as shown in Fig. 1, 27 member corporations of the Japan Federation of Construction Contractors (JFCC) worked in 14 treatment districts, treating approximately 50% of the total waste in both prefectures. In each district, waste treatment were performed while resolving many problems, and thanks to the guidance and support of local people, local companies, municipalities, and the government, treatment was completed by the end of March 2014, approximately three years after the disaster. This paper outlines the disaster waste treatment handled by the 14 districts.

Fig. 1 Areas for which the JFCC member corporations received orders for disaster waste treatment and the amount of waste treated in each area

2 GUIDELINE OF THE GOVERNMENT

Enormous amounts of disaster waste, such as that generated by the Great East Japan Earthquake, were treated in the past after the Great Kanto Earthquake

(1911) and the Great Kobe Earthquake (1995). Coastal landfill played an important role in the treatment of disaster waste from the Great Kanto Earthquake and the Great Kobe Earthquake. Meanwhile, in the case of the Great East Japan Earthquake, the government established a policy of recycling and reusing as much as possible in the “Guidelines for Disaster Waste Management” (Ministry of the Environment, 2011) officially announced two months after the disaster, partly because there was no major sea area landfill plan in the affected areas. In this guideline, disaster waste treatment was scheduled to be completed by the end of March 2014, approximately three years from the date of the disaster.

3 OUTLINE OF TREATMENT BY JFCC MEMBER CORPORATIONS

3.1 Treatment policies

The disaster waste was treated, focusing on completing the treatment as early as possible, recycling the waste, and ensuring safety against contamination, based on governmental and municipal guidelines and requests from local people in the affected areas.

3.2 Entire treatment flow

The entire treatment flow was as follows: transfer of waste from the primary temporary storage sites to the secondary temporary storage sites; intermediate treatment such as crushing, separation (including conversion of waste into reconstruction materials) at the secondary temporary storage sites; and transfer of recycled materials and residues after treatment. As shown in Fig. 2, the treatment works ordered by Miyagi prefecture included the incineration of combustibles in temporary incinerators as part of the intermediate treatment.

As shown in Fig. 3, the treatment works ordered by Iwate prefecture did not include incineration under its policy that existing cement factories and incinerators should be used as much as possible. Transfer from the affected areas to the primary temporary storage sites was mainly performed by local companies in the affected areas in both prefectures.

Radioactivity concentrations and radiation dose in the waste were carefully measured at each step of the treatment process, because the waste may contain radioactive materials caused by the Fukushima Daiichi nuclear disaster.

Fig. 2 Entire treatment flow (Miyagi prefecture)

Fig. 3 Entire treatment flow (Iwate prefecture)

3.3 Details of major treatment procedures

By following the procedures from (1) to (6) shown below, disaster waste were recycled rate as high as 88%, in Iwate and Miyagi prefectures (Ministry of the Environment, 2014). Figure 4 shows a typical basic treatment flow at the secondary temporary storage sites. (1) Treatment of concrete debris, wood debris, and waste metal

Concrete debris was crushed using crushers, and most of it was recycled as reconstruction material. Among the wood debris, materials of relatively good quality were taken out as raw materials for boards, and the rest was crushed into chips smaller than the specified size and incinerated. Metal waste was reused as scrap metal. Photos 1 and 2 show the crushing of concrete debris and wood debris.

Fig. 4 Typical basic treatment flow

Photo 1 Crushing of concrete debris (Otsuchi district, Iwate prefecture)

Photo 2 Crushing of wood debris (Yamamoto district, Miyagi prefecture)

(2) Treatment of fishing nets

The disaster damaged a number of fishing harbors, turning fishing nets into debris. Those fishing nets were sorted and shredded, and then transferred to final landfill sites. Some chemical fabrics used in fishing nets were subjected to material recycling. Weights made with lead and lead knitted into fishing nets, which increases the lead concentration in incineration ash, was

sorted and removed before incinerating the nets in temporary plants. Since it was difficult to sort and remove the lead using only machines, manual sorting was performed as well, in cooperation with local fishermen. Photo 3 shows an example of manual sorting of lead knitted into.

Photo 3 Manual sorting of lead (Kamaishi district, Iwate prefecture)

(3) Treatment of waste mixture (incombustibles/combustibles)

In each treatment district, various methods such as multi-stage separation (rough, rotating, wind, magnetic and manual separation, etc.) were devised, contributing to the increase in recycling ratio. Examples of each separation method are summarized below.

• Rough separation

Since toxic substances (such as asbestos and PCBs), hazardous articles (such as gas cylinders), and memorabilia (such as mortuary tablets and albums) were included in the waste mixture carried into the secondary temporary storage sites, rough separation was performed on the separating line first by heavy machines (such as backhoes with grapple) as well as manual separation. Rough separation was able to separate recyclable materials (such as metal waste and wood debris), toxic materials, hazardous materials and memorabilia from waste mixture. Photo 4 shows the rough separation of recyclable materials from waste mixture using heavy machines. Photo 5 shows manual separation to separate and recover memorabilia and valuable items from waste mixture.

Photo 4 Rough separation using heavy machines (Ishinomaki district, Miyagi prefecture)

Photo 5 Manual separation to recover memorabilia (Miyako district, Iwate prefecture)

- Separation using rotating screen

By rotating screen, soils were removed from the waste mixture and classified after rough separation. Photo 6 shows an example of separation using rotating screen.

Photo 6 Separation using rotating screen (Otsuchi district, Iwate prefecture)

- Separation using wind separation machine

The waste was then separated into light combustibles and heavy incombustibles using wind separation machines, etc. Photo 7 shows an example of separation using wind separating machines.

Photo 7 Separation using wind separation machines (Iwanuma district, Miyagi prefecture)

- Manual separation

Manual separation was then performed to classify the waste into memorabilia, recyclable materials, combustibles, and incombustibles once again. Many local people were employed as manual separation workers. Photo 8 shows an example of manual sorting.

Photo 8 Manual separation (Watari district, Miyagi prefecture)

(4) Incineration of combustibles

Incineration was included in the waste treatment work ordered by Miyagi prefecture. A total of 26 temporary incinerators (treatment capacity: 4,180 t/day) were installed in 8 treatment districts to efficiently incinerate combustibles separated from the waste mixture for volume reduction. Table 1 lists the temporary incinerators in each treatment district.

Table 1 List of temporary incinerators in each treatment district

Block	District	Type of incinerator	Capacity (t/day)	Quantity (unit)	Total (t/day)
Kesenuma	Kesenuma	Kiln	219	1	766
		Kiln	109	1	
		Stoker	219	2	
	Minamisanriku	Stoker	95	3	285
Ishinomaki		Kiln	300	2	1,588.2
		Stoker	329.4	3	
Miyagi East block		Kiln	210	1	320
		Stoker	110	1	
Watri-Natori	Natori	Stoker	95	2	190
	Iwanuma	Kiln	95	1	195
		Stoker	50	2	
	Watari	Stoker	105	5	525
	Yamamoto	Kiln	200	1	309.5
		Stoker	109.5	1	
Total		Kiln:7units Stoker:19units		26	4,178.7

Photo 9 shows the temporary incinerators in the Ishinomaki district. The three units on the left are stoker incinerators suitable for combustibles such as wood chips, plastic scraps and paper wastes, and the two on the right are kiln incinerators suitable for mixtures containing soils. Impurities in the exhaust gas generated from the temporary incinerators were safely removed by filtration-type dust collectors (bag filters) to meet environmental standards.

Photo 9 Temporary incinerators in operation (Ishinomaki treatment district, Miyagi prefecture)

In addition, biomass power generation facilities using woody materials as fuel were installed to provide part of the electric power necessary to operate the secondary temporary storage site in some treatment districts. Photo 10 shows an example of woody material biomass facilities in operation.

Photo 10 Woody material biomass facilities in operation (Yamamoto district, Miyagi prefecture)

(5) Granulated solidification of incineration ash

Crushed incombustibles, cement and insolubilizing agent were mixed into the main ash, which was low in radioactive or toxic substance concentrations, of the ash from the incinerators, to form granulated solidification materials. The quality of these granulated solidification materials was checked and they are now used such as earth filling materials in public reconstruction projects, etc. Photo 12 shows an example of harbor land filling using granulated solidification materials, etc.

Photo 11 Granulated solidification facilities in operation (Minamisanriku district, Miyagi prefecture)

Photo 12 Harbor land filling using recycled materials (Ishinomaki district, Miyagi prefecture)

(6) Treatment of tsunami deposits

By disaster waste treatment works, the separated soils or recovered soils were obtained from tsunami deposits and waste debris. These materials (soils) are being used for public reconstruction work.

A “Guideline for Utilization of Treated Wastes for Recovery Works” (Iwate Prefecture, 2013) has been published by Iwate prefecture under the supervision of the Japanese Geotechnical Society, in which recovered soils are categorized namely “Recovered Soil Class A” and “Recovered Soil Class B” depending on their origin and nature. “Recovered Soil Class A” is the soils separated from soil-dominant stockpiles (mostly tsunami deposits), “Recovered Soil Class B” is the soils separated from waste-mixed stockpiles such as by rotated screen. Photo 13 shows the separation of Recovered Soil Class B performed.

In the treatment work ordered by Miyagi prefecture, the soil washing contributed to separate soils from tsunami deposits. Photo 14 shows the on-site soil washing plant in Miyagi prefecture.

Photo 13 Separating soil B by rotating screen (Yamada district, Iwate prefecture)

Photo 14 On-site soil washing plant in operation (Minamisanriku district, Miyagi prefecture)

(7) Quality control

Recycled materials and residues treated in the secondary temporary storage sites were subjected to quality check including measurement of composition, salt content, radioactivity concentration, radiation dosage, etc. and then taken out for recycling or to the final landfill sites. Photo 15 shows the onsite quality control room.

Photo 15 The onsite quality control room (Minamisanriku district, Miyagi prefecture)

3.4 Operation control of transportation vehicles, etc.

Since many transportation vehicles had to transport disaster waste, etc. on a limited number of transportation routes (local roads had been severely damaged), it was essential to ensure efficient vehicle operation control and safety control giving priority to the safety of local residents. Each treatment district used GPS, etc. and provided operation control systems appropriate for each site condition to ensure efficient

and safe operations. In treatment districts where the secondary temporary storage site was close to the sea, marine transportation was also used to ensure efficient transportation. In addition, in the waste measurement control, a bring-in/out control system that could centrally manage the measurement information from truck scales in the primary and the secondary temporary storage sites was developed to ensure efficient control.

3.5 Removal/recovery in the secondary temporary storage sites

(1) Disassembly of temporary incinerators

Temporary incinerators with interiors contaminated by dioxins, etc. were disassembled according to the applicable laws and regulations under the guidance of supervisory authorities. The following procedures were followed to prevent toxic substances from spreading to the outside: installation of tents covering the entire incinerators, removal of toxic substances by washing the interiors of the incinerators, and disassembly of temporary incinerators. Photo 16 shows an example of the disassembly of a temporary incinerator.

Photo 16 Disassembly of a temporary incinerator (Kesenuma district, Miyagi prefecture)

(2) Restoration of original state

The foundation of the treatment facilities and the pavement of the secondary temporary storage site were removed after disassembly of treatment facilities, and then the soil survey was performed to confirm the absence of soil contamination at the ground. At last, the original state was restored. Photo 17 shows the soil survey at a secondary temporary storage site.

Photo 17 Soil survey at a secondary temporary storage site (Iwanuma district, Miyagi prefecture)

3.6 Environmental measures

Each district performed control against exhaust gas, noise, vibration, odor, degradation of water quality, etc. by taking environmental countermeasures to protect surrounding areas and conducting environmental monitoring depending on the site conditions. Photo 18 shows an example of measuring the quality of the exhaust gas from a temporary incinerator. Various measures were also taken to create a safe working environment: installation of ventilating facilities and air-conditioners in manual separating facilities, provision of protective gear for workers, etc. Photo 19 shows typical protective gear for workers.

Photo 18 Measurement of the quality of the exhaust gas from a temporary incinerator (Natori district, Miyagi prefecture)

Manual separation of waste mixture

Management of temporary incinerator

Crushing

Photo 19 Typical protective gear for workers (Watari district, Miyagi prefecture)

3.7 Contribution to local communities and exchange with local people

(1) Contribution to local communities

Another major task of the disaster waste treatment was to serve the local communities, stimulating the local economy in the affected areas. A lot of materials and equipment used for waste treatment works were procured from local corporations and the commerce and industry association, and local people for manual separating work were employed on a priority basis. Efforts were also made to improve the skills of local people by providing practical technical training courses, etc. Photo 20 shows special training on an aerial work platform intended for local people.

Photo 20 Special training on an aerial work platform (Otsuchi district, Iwate prefecture)

(2) Communication with local people in each treatment district

Close communication with local people was established by organizing treatment site tours for them, sponsoring and participating in local events, establishing nurseries for local workers, etc. In addition, information was frequently distributed to local people by creating unique websites and issuing periodic information magazines to build trust and a better understanding of the details of the work. Photo 21 shows the site tour/hands-on tour intended for junior-high students.

Photo 21 Site tour/hands-on tour intended for junior-high students (Miyako district, Iwate prefecture)

4 PROPOSALS FOR FUTURE

Major disasters such as earthquakes directly below the Tokyo area and major Nankai Trough earthquakes are expected to occur in the future. As measures necessary to treat the waste from such major disasters quickly and smoothly, we make the following suggestions based on our experience of treating disaster waste this time:

- Disaster-related comprehensive agreements, such as wide-area treatment agreements among administrations and disaster-related agreements between the government and businesses, should be concluded in advance.
- Possible temporary storage and waste treatment

sites, temporary recycled material storage sites, etc. should be identified during normal times.

- Standards for usage and quality of reconstruction materials and recyclable materials should be established in advance.

- Numerical data such as basic units allowing the amount of disaster waste to be estimated early, accurately, and efficiently should be compiled.

- Order procedure should be advanced quickly to start waste treatment works as early as possible.

5 CONCLUSION

The Disaster Waste Section of the JFCC has compiled specific details on waste treatment, know-how, data, and proposals for future disaster waste treatment into a comprehensive report (JFCC, 2014) (see Photo 22), based on the actual disaster waste treatment performed by JFCC member corporations in 14 treatment districts. We hope that the report will assist disaster waste treatment in the event of major disasters in the future.

Photo 22 “Report on the treatment of disaster waste generated by the Great East Japan Earthquake” compiled by the Disaster Waste Section of the JFCC

Lastly, we are deeply appreciative to have finished the huge amount of waste treatment with the full support of the local people, local businesses, and the government officials.

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