Study of an application to the East Japan great earthquake disaster revival of Tray type Closed System landfill site(TCS)

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Abstract

The East Japan great earthquake disaster that occurred on March 11, 2011 brought broad-based human and material damage. The quantity of disaster waste (debris) is 22,500,000 tons, and the quantity of soil and waste through the decontamination process which is anticipated to be enormous by 16,400,000-41,000,000m^3. Although the reconstruction of the stricken area is under way, many unfinished problems are still left.

Under these circumstances the Authors have researched and developed Tray type Closed System landfill site(TCS) which is the landfill site to be intended to improve reliability and safety , to reduce costs, and to shorten the construction period. We believe TCS could be realized in a much easier way than the conventional landfill site due to its characteristics. We hope that TCS will be used for temporary storehouses or landfill sites of the east Japan great earthquake disaster waste, and also for temporary storehouses or interim storage facilities of waste and soil contaminated by radioactive material. We hope that TCS could contribute to the earthquake disaster reconstruction, too.

Keywords: Closed System landfill site(CS), Disaster waste, Earthquake disaster reconstruction, East Japan great earthquake disaster, Tray type Closed System landfill site(TCS)

Introduction

The traditional Closed System landfill site(CS) often construct the rectangle structures by the concrete retaining wall or the reverse trapezoid structures with the steep grade by the reinforced embankment method of construction in order to reduce the area of the covering part of the landfill (such as a roofed area of the landfill) which is having high construction costs. These structures become the big factor of the increase in costs. In addition, in case of CS, the large quantity of the earthwork is necessary for excavating and filling at construction area. In proportion to the quantity of this earthwork the scale of construction and the cost become greater.

On the other hand, TCS is installed at the flatland by setting the tray type container with a shallow bottom as a landfill. In this way one could drastically reduce the construction cost by minimizing the scale and quantity of the earthwork and also numbers of structures.

1. Scale of TCS standard model

Table-1 shows the numbers and ratios of non-industrial waste landfill sites in our country according to the final capacity of the landfill. About half of the total numbers of the non-industrial waste landfill sites in our country is less than 50,000m^3, and 2/3 is less than 100,000m^3. Due to the recent promotion of waste reduction and recycling, scale of the landfill has a tendency to become smaller. Judging from these facts, if we select 50,000m^3 as

the scale of the TCS standard model, about half of the landfill sites would be covered. In addition, 100,000m^3 scale landfill which occupies 2/3 cases in our country would be also covered by setting 2 units of 50,000m^3 TSC standard model. Therefore, we decide the scale of the TCS standard model to be 50,000m^3.

The basic elements of the standard model assumes only 1 unit and elements are decided following from above examination: scale of landfill is 50,000m^3, width is 50m (maximum width of the common tent structure), length is200m.

Table-1 Numbers of non-industrial waste landfill sites in Japan on a scale basis

Scale of landfill site	Numbers of sites		Ratio on a scale basis	
～50,000	878	1,216	48%	67%
50,000～100,000	338		19%	
100,000～500,000	471		26%	
500,000～	122		7%	
Unknown	1		0.1%	
Total	1,810		100%	

HP from Japan Environment Ministry (2010 record)

2. Structure of TCS standard model

(1)Storage structure

The precast concrete wall has been selected as the wall of the storage structure, for the purpose of the standardizing the design criteria which enables the simplification of the whole design and the shortening of a design and construction period.

In addition, a cast-in-situ concrete has been selected as a base slab in order to maintain the continuity between wall and base slab of the storage structure and the facilitation of construction.

The construction procedure of the storage structure is as follows.

① Create the base ground by flattening and compacting and then lay the double impermeable liner (red in Figure-1).

② Lay 30cm of sand (brown) for protecting the liner. After compacting the sand, cast lean concrete (grey) on top of sand.

③ Set the precast wall on the lean concrete, bring up the liner through the outer surface of the wall and fix the liner at the top of the wall.

④ Fit H-beam on top of the wall for the base of the tent structure. Set reinforcement bars and cast concrete of the base concrete.

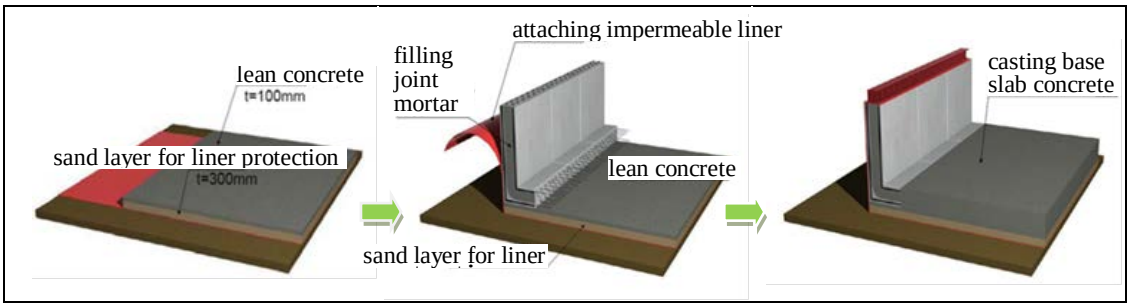

Figure-1 The construction procedure of the precast storage structure

(2)Seepage control method

TCS is a landfill with a reinforced concrete structure (RC structure) having a flat base slab and a perpendicular sidewall. Among landfills with a RC structure, some regard the RC structures itself to be impermeable by making sidewalls impermeable concrete. On the other hand, even in RC structure, there are many cases that the double impermeable liners are installed to both base slabs and sidewalls.

TCS is made of combination of precast wall and cast-in-place concrete of base-slab. Therefore we do not expect high permeability in RC structure and we do install the double impermeable liners to both base slabs and sidewalls.

In order to avoid the liner to be torn or damaged during landfilling, the double impermeable liners are installed outside of RC structure.

(3) Covering facility

The tent structures or the wooden roof with iron framework have been used in traditional closed system landfills. In case of TCS, the covering facility is installed only at the part of

total area of landfill, and this covering facility will be slid on the guide beam along with the progress of the landfilling. In this study, we select the tent structure as a covering facility because there are many achievement of introducing sliding tent structure in closed system landfill.

We select 50m spam because the maximum spam of common tent structures is 50m.

We examine the most economic length of the roof of the tent structure next. The length of the roof will be shortened according to the numbers of frequency of transference of the roof. Assuming the disposal period as 15 years, we examined it with four cases from a case to transfer every year to a case to transfer once in five years. The construction costs of a kind of tent materials are calculated from the building application classification (temporary construction building, simple building, general building), and the length of the roof and the transference costs are calculated from number of times of transference and movement distance per transference. As a result of comparing the each case, roof length was decided as 60m. At 60m in the roof length of case 3 proved to be most economical in case of transference four times during total landfill period.

Sliding houses with traditional wooden roof with steel frames and system buildings are commonly performed and approx. 50m spam is actually recorded. Therefore traditional roof types can be adopted, too.

Figure-2 Photo of inside view of tent structure (Width 50m)

(4) Leachate collection & discharging facility and rainwater drainage facility

Landfill site is divided by section embankment(W500 ㎜×H200 ㎜) into 5 pieces. The bottom slab of the landfill has 1% inclination in the crossing direction to drain the rain water and leachate water to the downstream by each division. This water will be drained outside of the landfill at one point of each division.

The rainwater to the divisions in which the landfilling is not yet started without roof facilities will be just drained out without treatment. All the water draining from the division in which the landfilling is in progress with roof facilities and also from completed divisions will be treated as leachate. Therefore Leachate collection & discharging facility in landfill area has the function of collection & discharging facility for rainwater, too. We set up 2 parallel drainage systems outside the landfill to let the leachate and the rainwater flow into each system separately. The drainage facility from each division of landfill must have the function that can choose the either pipe along with the progress of the landfilling. More specifically, rainwater from non- landfill area must be connected with rainwater drainage pipe set outside (U 300) ,and leachate water from both in progress and completed division must be connected with leachate water drainage pipe set outside(VUφ300). This conversion will be done by the valve set in the water delivering facility in each division.

3. Specifications of TCS standard model

Having studied structures of each facility, specifications of TCS standard model are as follows.

① Volume of landfill: 50,000m^3
② Shape of landfill site: width 50m×length 200m×storage hight2.0-2.5m
③ Area of landfill: width49m×length199m=9,751m^2
④ Covering facility: spam50m×length60m=3,000m^2 , height 13m , numbers of sliding during total landfill period: 4times
⑤ Leachate treatment capacity: 11m^3/day
⑥ Shape of landfill site after completion: height of landfill 9m, height of slope 7m, grade of slope1:1.8
⑦ Area of the top of landfill after completion: with21.8m×length171.8m=3,745 m^2

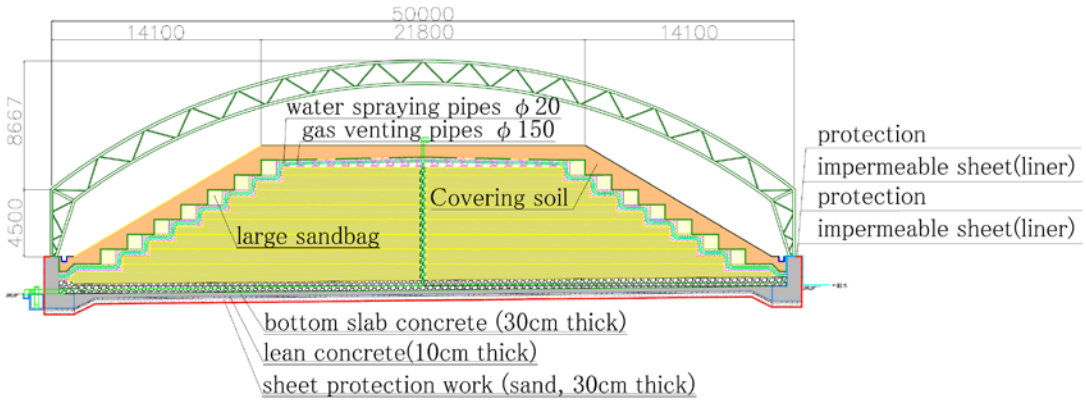

Figure-3 Cross section of TCS standard model on completion of landfill

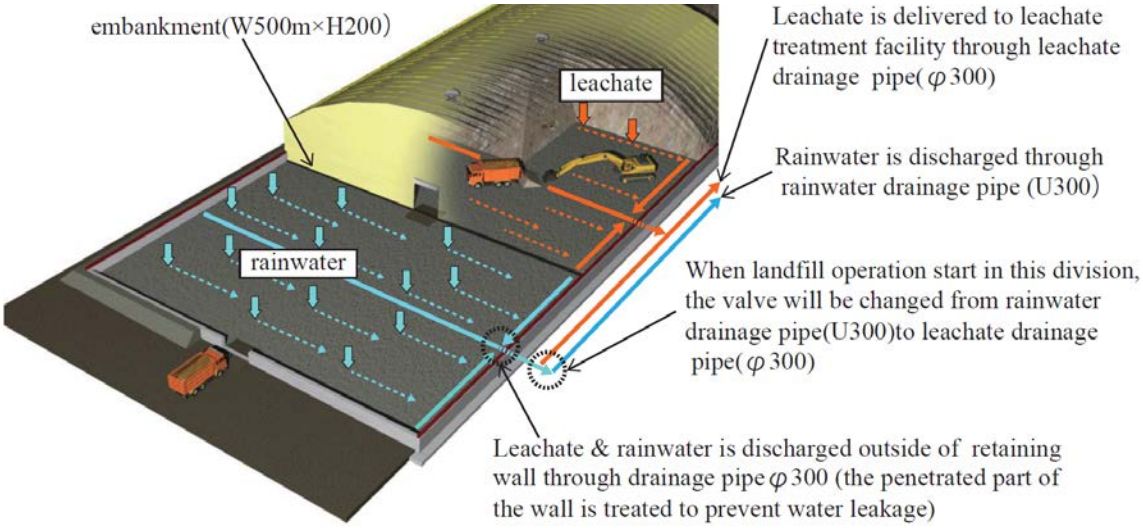

Figure -4 Image view of TCS landfilling and collection & discharging facility of leachate & rainwater

4. Features of TCS

Features of TCS are summarized as follows:

① TCS is a simple structure to set up a tray-type container flat on the ground, therefor the higher reliability and safety become possible by standardizing the design criteria with high technical maturity.

② Because of the impermeable liner installed on the outside retaining wall, the risk of sheet damage during the landfilling is reduced.

③ Construction period can be shortened significantly by prefabrication of the landfill site and standardizing the design criteria.

④ TCS can be constructed in a short time period for the purpose of the temporary storage and for emergency usage in case of illegal dumping and also during natural disaster.

⑤ Because TCS is ground-mounted type, it is easy to construct even near rivers and coastal regions with high ground water level.

⑥ TCS will reduce the volume of earthwork and scale of construction, thus it reduces much costs and many construction items.

⑦ TCS is easy to excavate due to shallow landfill. The risk of sheet damage during re-excavation is small, because the sheet is set outside of the wall and the bottom slab; therefore TCS also is suitable for practical use of short-term storage. TCS is the ideal landfill system for the recycle-based society.

⑧ TCS will be used also for temporary storages or interim storage facilities of waste and soil contaminated by radioactive materials.

5. Method of TCS landfill

TCS landfill follows the procedure shown below.

① Waste transporting vehicles roll directly into the landfill site.

② After the first level landfill is completed to make an effective landfill shape, the large size sandbags are set surrounding the second level landfill area, so that the inclination of final level will adjusted to stability inclinations (1:1.8). After that the waste landfill re-starts and repeats levelling, compaction and setting. Size of the large sandbag is 1m×1m×1m.

③ After the landfill of a section is completed up to the planned height, the section is covered by impermeable sheet as capping (green line) to prevent rainwater from infiltrating. After that the final covering soil layer is installed.

④ The covering roof is slid after the installation of the final soil layer.

⑤ Gas venting pipesφ150 and water spraying pipesφ20 are installed in accordance with the progress of the landfill. Gas venting pipes collect the landfill gas, and discharge it to the air. In addition gas venting pipes have the air supply function to promote the stability of the landfill. And after the final covering soil is installed the stability of the landfill is promoted also by washing out effects by sprinkling water on the covering soil. Leachate collected at the bottom slab is treated at the leachate treatment facility.

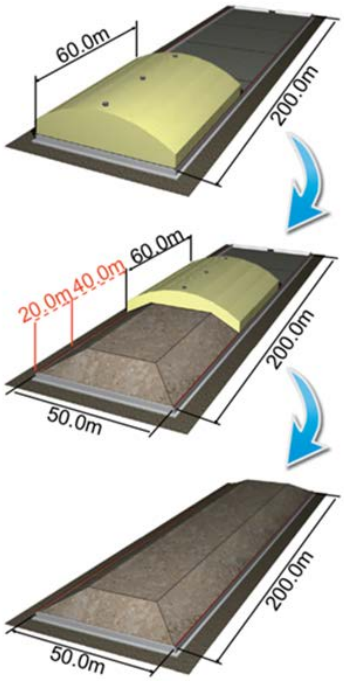

Figure-5 Sliding the covering facility as landfill progresses

6. Application to the reconstruction of East Japan great earthquake disaster

(1) Consideration about the application of TCS to landfill site of disaster waste and the radioactive contamination.

Since TCS is a management type landfill site, there is no problem to utilize TCS as landfill site of disaster waste. TCS will not be selected in disaster-stricken areas where large amount of disaster waste occurred because TCS landfill scale is small. TCS can be used in any case except above-mentioned scale.

TCS will be effective in temporary storages or interim storage facilities of waste and soil contaminated by radioactive materials and in landfill site for designated waste by the following reasons

① Burden of construction workers are less heavy even in the high radioactive area because construction period is short.

② TCS can contribute to early recovery because TCS is not influenced by rain and wind.

③ TCS can be enlarged by extending its length or increasing numbers of units according to the necessity. TCS is possible in small scale and the gradual extension in its scale is possible, too.

④ TCS is closed system, so treatment of drainage water is not necessary during landfilling.

⑤ TCS is ground-mounted type, so the risk of infiltration of rainwater and ground water is small.

⑥ The risk of sheet damage during re-excavation is small.

⑦ In case of using as temporary storages or interim storage facilities, removal after usage is easy.

(2)Application to disaster waste disposal treatment

The quantity of outbreak of the disaster waste (debris) is estimated to be 22,500,000 tons. The policy of disposal treatment is that firstly the waste goes through segregation process as

much as possible, and then recycling and incineration treatment are performed as much as possible, and finally a residual substance and incinerated ashes are subjected to landfill. Therefore, the quantity of waste going to landfill in Iwate and Miyagi prefectures is guessed with approximately 2,500,000-5,000,000m^3. When the quantity of the waste to be treated in wide area (i.e. outside the prefectures) is excluded, the expected quantity of the landfill treated in both prefectures becomes approximately 2,000,000-4,000,000m^3.

However, the remaining capacity of the landfill sites for non-industrial waste in both prefectures is only 9,130,000m^3 at present. If total quantity is disposed at these landfill sites, the remaining quantity decreases sharply. Therefore the wide-area disposal policy is required including landfill sites for industrial waste. TCS will have opportunities if existing landfill sites are not acquired.

Figure-6 Disaster waste in East Japan great earthquake disarster

(3) Application to the soil and waste occurred by decontamination

Fukushima-first nuclear plant accident occurred by the tsunami of the East Japan great earthquake disaster, and pollution caused by the radioactivity such as cesium spread in wide area. Therefore the outbreak of soil and waste by decontaminating radioactive contamination is anticipated to become approximately 16,400,000-41,000,000 m^3. These waste are planned to be stored in the interim storage facilities to be newly constructed or the existing management type landfill sites. However, TCS will have an opportunity in case that the constructions of new storage facilities are not in time, and that remaining landfill quantities are not sufficient.

(4) Application of the designated waste to the management type landfill

The sludge from the sewage disposal plant and the incinerated ashes with high cesium density which occurred by the incineration of waste contaminated by radioactive materials are named as the designated waste. And they must be disposed in the management type landfill site. The quantity of this waste is approximately 50,000m^3 now in 8 prefectures including Tokyo from Kanto region to the north, and it is anticipated to increase in future.

The designated waste is supposed to be disposed in the existing management type landfill site, but TCS will have an opportunity to participate in case that remaining capacity of the existing landfill is not sufficient.

Summary

As for the securing of landfill sites for disaster waste and designated waste, the wide-area cooperation is given first priority, and the interim storage facilities are expected to be installed according to time schedule.

However, if the wide-area cooperation and timely installation is not sufficient, we would like to promote and study the application of TCS for the reconstruction of the disaster.

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