ENGINEERING METHODS AND ECONOMIC EFFECTS ON REPRODUCTION TECHNOLOGY OF FINAL DISPOSAL

Tomoaki HACHIMURA*, Minoru YAMANAKA**, Shuichi HASEGAWA** and Hiroyuki OHNO***
Japan Environmental Sanitation Center*
Kagawa University**
Kankyo Chishitsu Co.Ltd***

***ABSTRACT*:** A waste disposal landfill institution is very important infrastructures for economic and social development. However, construction of the landfill projects are becoming tough task every year because of perturbing community for environmental issues related with engineering structures and kind of waste disposals. Similarly, the completed landfill and waste disposal sites need to be promoted for economical point of views. In order to tackle these issues, it can be consider a reproduction of wastes disposal landfill. The reproduction of waste disposal landfill can contribute to promotion of 3R, a prolongation of its operation period, a substantiality of environmental preservation, a countermeasure against global warming and so on.

In this paper, the authors describe engineering methods and business process to be suitable for the reproduction of waste disposal landfill, and discuss result of model calculation on the economic effect when applied to reclaim for final disposal.

KEYWORDS: final disposal, landfill, business process for reproduction, construction cost

1. INTRODUCTION

Various activities are carried out for establishing of a recycling society in a global scale. Japan's basic approaches to manage the municipal solid waste are (1)waste reduction, (2)promotion of recycling process, (3)bulk reduction in amount by intermediate treatment, and (4)environmentally beneficial final disposal. Japan has been making active efforts to establish a recycling- oriented society based on the 3Rs i.e. Reduction, Reuse, and Recycling with accomplished laws accordingly. They include the Law for Promotion of Utilization of Recycled Resources in 1992, Basic Law for Creation of a Recycling-Oriented Society in 2000 and several other recycling related laws and regulations (Tanaka, 1999).

The creation and proper management of waste disposal landfill are an indispensable part of a society for aspiring to become the recycling society (Ohno, 2007, Hachimura, 2009). Although landfills are essential facilities of communities, there are many difficulties for new construction of waste disposal landfill in the recent years because of extreme concerns about the environmental degradation of the sites and degree of danger of the waste disposed in the landfill. If recycling society is established, construction of landfill site is solved. However, quantity of waste decreases in present Japan, but rest capacity of landfill in Japan is not enough at all in the long term.

Because a landfill site cannot reconstruct easily, it is necessary to carry out detail investigation for stabilization and possible reproduction of landfill sites (Ono, 2000). Until now, Japanese government has decreased volume of recycled wastes by an intermediate treatment of garbage in stead of disposed in a landfill sites. However, it is thought

that most of existing landfill site is filled up without passing an intermediate process. In this case, long term use of existing landfill site is impossible without recycling the reclaimed waste.

This paper describes the engineering methods and suitable economical methods for the replication of existing landfill site, and discusses the result of a model calculation on the economical benefit when applied to reclaim final disposal.

2. WASTE DISPOSAL TREATMENT IN JAPAN

Fig.1 shows the process of treatment and disposal of wastes from production to final disposal in Japan. Firstly, the unnecessary ones is recycled, reduced its volume, stabilized, changed to inorganic matter in quality, and/or changed to detoxification. Finally, a solid incineration residue is disposed into waste disposal landfill. Final disposal is a process of assimilation of waste naturally. The filled waste is patched up into a soil naturally by depending on ability for purification, and is utilized as a ground of completed landfill.

Fig.2 shows the amount of discharge of municipal solid waste in Japan and its treatment (Waste and Recycling Division, Ministry of the Environment Government Japan, 2008). The ratio of final disposal decrease largely from 1975 to 95, and the ratio of incineration increases adversely. This is because of enforcement of intermediate treatment such as

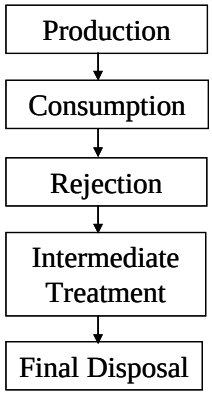

Fig.1 Process of treatment and disposal of wastes

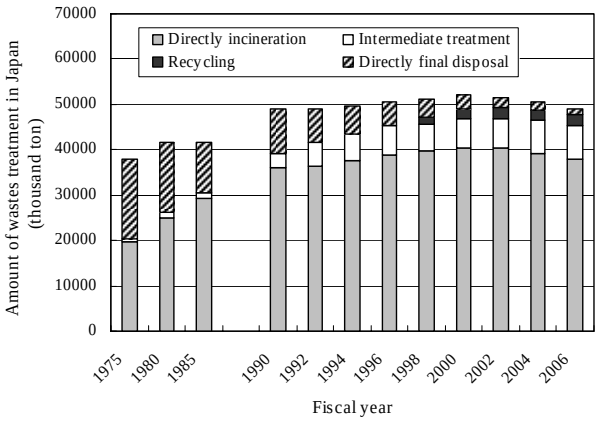

Fig.2 Amount of wastes discharge and treatment

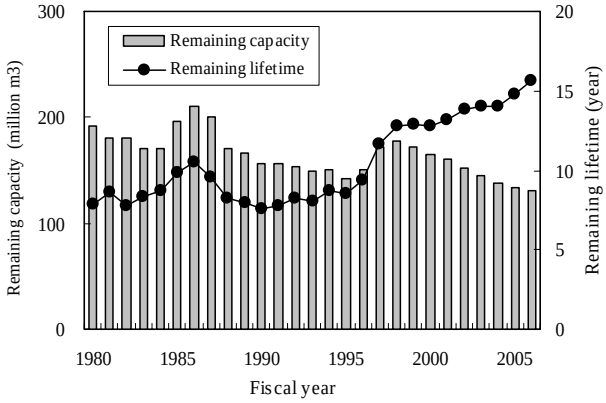

Fig.3 Remaining capacity and remaining year of final disposal

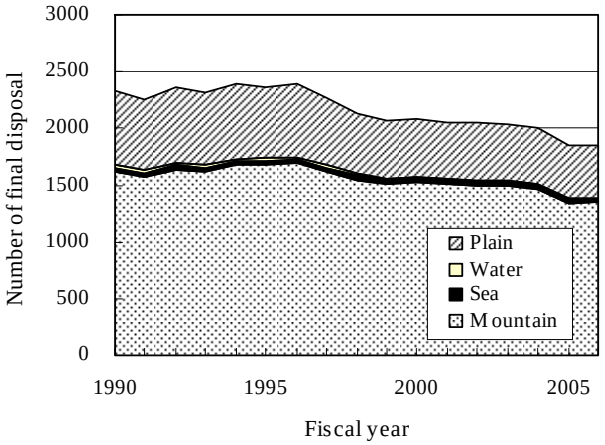

Fig.4 Number of final disposal

reducing or stabilization with increasing of wastes quantity, this means that quality of waste has changed to inorganic matter.

Fig.3 shows the remaining capacity and remaining lifetime of final disposal of municipal solid waste in Japan (Waste and Recycling Division, Ministry of the Environment Government Japan, 2008). In 2005, the remaining capacity is 130.4 million cubic meters,

and the remaining lifetime is 15.6 years. Therefore the difficult situation in securing final disposal facilities continued unchanged as the remaining capacity decreased, while slight increase in remaining lifetime due to the decrease in volume of waste.

Fig.4 shows the number of final disposal of municipal solid waste in Japan. The number of final disposal decrease year by year. There are 1853 sites in 2006 under operating in Japan. In addition, there are considerable numbers of final disposal sites if numbers of ones that filling has finished are added. In these, it is considered that it was constructed in these in 1970's, and that there is considerably site including a final disposal which did not carry out an intermediate processing.

Therefore, it can be said that a reproduction of existing final disposal is an effective method for a increase of disposal capacity by the prolongation of lifetime of final disposal, for a decrease of negative inheritance by re-treatment and recycle of filled waste, for a preservation of local environment, etc,.

3. FINAL DISPOSAL

3.1 Structure of final disposal

Fig.5 shows the diagram of final disposal site. The structure of final disposal of municipal solid wastes corresponds to controlled type of final disposal of industrial wastes. Therefore some main facilities such as solid wastes retaining structure, seepage control work, water treatment are constructed in control type of final disposal.

3.2 Demand technologies to reclaim final disposal

Table 1 lists technologies that are necessary to reclaim final disposal. These technologies classified as 3 parts of reproduction technology of filled wastes, safety improvement technology for structure of final disposal, and environmental preservation technology.

Table 1 Demand technologies to reclaim final disposal

Reproduction technology of filled wastes
Recycle technology, Decrease technology of volume Purification and Stabilization technology
Safety improvement technology for structure
Solid waste retaining structure, Seepage control works, Leachate collection facility, Leachate treatment facility
Environmental preservation technology
Air pollution, Noise and Vibration, Water pollution

4. COMPREHENSIVE TECHNOLOGICAL SYSTEM FOR RECLAIM LANFILLS

Construction method in comprehensive technological system for reclaim landfills and it consists of conventional technology such as reclamation, development, intermediate treatment and so on. Therefore, if these technological applicability and influence to neighboring environment are examined enough, it may be said that the system is able to introduce easy as a method

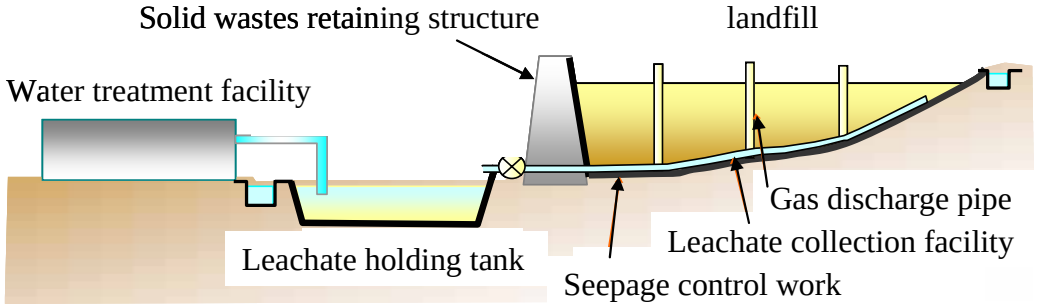

Fig.5 Diagram of final disposal (controlled type)

of construction

Fig.6 shows flow of comprehensive technological system for reclaim landfills (Higuchi, 2005).

4.1 History of landfill

It is very important to survey the history of landfill in order to judge the effect on introducing new system at first. As for the history of landfill site, existing records or documents on the final disposal play a key role.

4.2 Investigation of wastes layer

Because detailed record of a reclaiming situation according to kind of garbage is not left in final disposal, it may occurs an accident that methane and hydrogen sulfide gas spout out under excavating. It is necessary to investigate the reclaiming position according to quality (organic, inorganic, etc.) of garbage in wastes layer. The high density electric logging per 1m in depth, and the surface wave velocity exploration are effective for investigation of wastes layer.

4.3 Boring and test pit

A position of boring or test pit can be decided from the result of history survey and/or boring survey. And, an effective reproduction of the landfill can be judged by composition analysis of wastes sampled from borehole drill hole.

4.4 Composition analysis of wastes

Physical and chemical analysis of sample are carried out in detail. This analysis suggests basics information about reducing volume of filled wastes. In addition, a water quality analysis is carried out to understand seepage and leaking. This enables reasonable treatment of seepage water by predicting water quality.

4.5 Discussion of method to reclaim final disposal

It can be considered that there are mainly three methods to extend lifetime of landfill disposal has main; 1) decrease of volume by recycling valuables such as aluminum or iron material from garbage

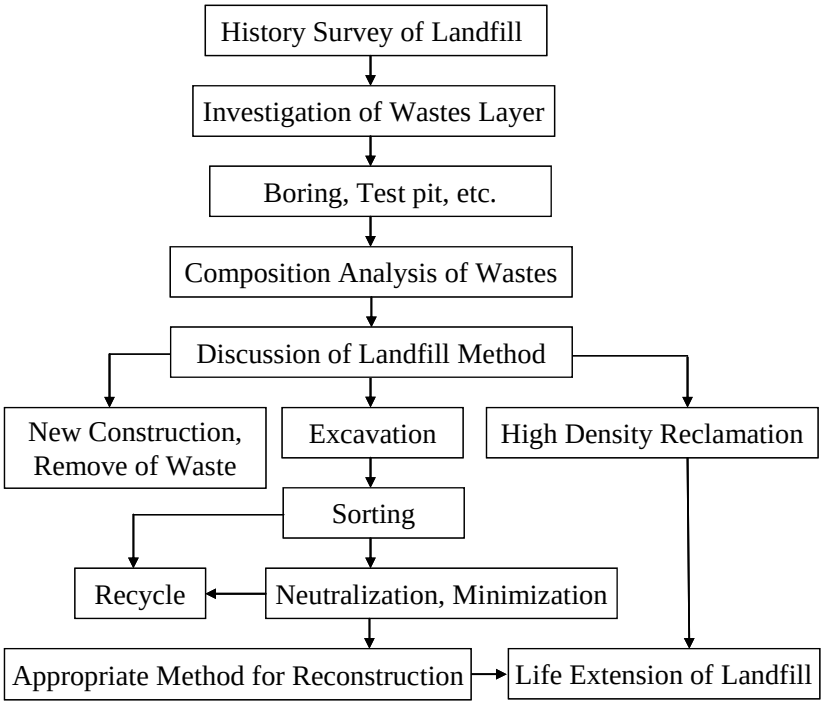

Fig. 6 Flow of comprehensive technological system to reclaim landfills

under excavation, or by crashing and compressing plastics, 2) creation of new reclaimable space by re-treatment of combustible waste by incinerating and/or melting, 3) high density reclamation by falling counter weight typed dynamic consolidation, or by oil pressure typed static consolidation. A method to adopt is usually decided from the suggestions from the prolongation of lifetime, environmental preservation, economy and so on based on quality of filled garbage.

4.6 Development of neutralization and stabilization of filled garbage

It is necessary to carry out neutralization or stabilization of the site when excavated garbage is reclaimed again after sorting or crashing. This process promotes early stabilization of final disposal and gets possible to utilize garbage which did detoxification as the cover soil.

4.7 Recovery function of final disposal

It is important to restore them when damage of seepage works or stoppage of leachate collection pipe and/or gas discharge pipe etc was detected under excavating garbage. This process can promote a function recovery at the early stage of final disposal and a termination of post-closure of landfills.

4.8 Others

In order to utilize incineration residue as a cement raw material, it prefers to move the residue for a cement factory after washing the residue on the site to remove salt , which is the disincentive.

5. OPERATION PROCESS

Fig.7 shows the operation process and time of decision for comprehensive technological system to reclaim landfills. For time of planning and operation for project to reclaim landfills, it is similar mainly with a process of general project process, advance in 1) fundamental investigation stage, 2) ground plan stage, 3) ground design stage, 4) executive design stages. It is very important to grasp expected business risk adequately because various risks under

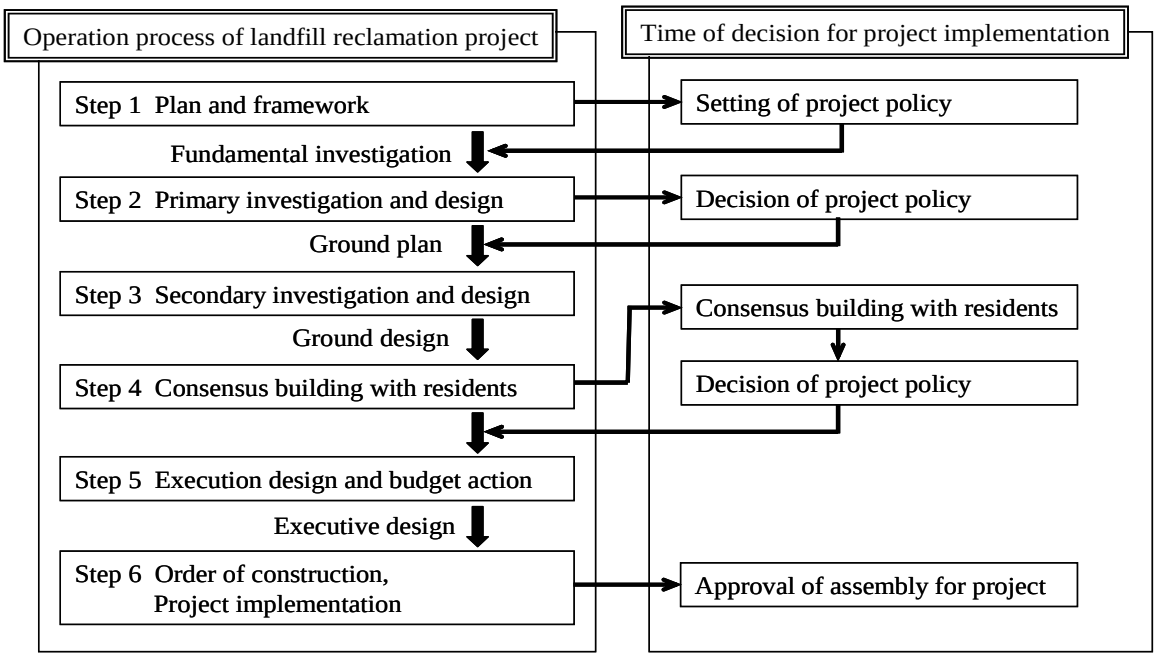

Fig. 7 Operation process and time of decision for comprehensive technological system to reclaim

construction are large in the operation process of reproduction project of final disposal. It is necessary to discuss adequately at each stage to reduce a risk with progress of a project. It can be said that it is appropriate method to reduce a risk to push forward a project step by step while conducting a necessary investigation.

In addition, setting and decision of project policy and consensus building with resident at each stage are very necessary for the project implementation as shown in right side of Fig.7

6. ECONOMIC EFFECT

6.1 Condition of calculation

As for discussion of economic effect of reproduction of final dispose, it makes model calculation of detailed cost for excavating, sorting and intermediate treatment under a certain condition (Research organization on reproduction technique of final disposal, 2005).

Table 2 shows the composition of these filled wastes. In this calculation, three cases of the filled waste were used as follows;.

Case-1: Filled waste including plastics mainly

Case-2: Filled waste mixed with plastics and incineration residue

Case-3: Filled waste including incineration residue mainly

6.2 Result of calculation

Table 3 shows the calculation result of each process. The calculation result of the cost is explained each in following sections.

6.2.1 Excavation, sorting, hauling

For Case-1 to Case-3, in the case of rough sorting only, it was calculated with 5600, 5200, 4800 (JPN yen / waste ton) respectively. But for Case-2, the cost increase as 12300 (JPN yen / waste ton) even the sorting was carried out with rough sorting by machine.

6.2.2 Melting treatment

For Case-1, if the fluidizing gasification was carried out for the filled garbage to include plastic mainly, it costs 9500 (JPN yen / waste ton). On the other hands, For Case-2, if the batch melting was adopted for the filled waste mixed with plastics and incineration residue, it costs 18100(JPN yen / waste ton). For

Table 2 Composition on filled wastes

Property / Wastes	Composition (wet %)			Composition (vol %)			Bulk specific gravity (t/m^3)
	Case-1	Case-2	Case-3	Case-1	Case-2	Case-3	
Plastic	80	40	0	86	46	0	1.0
Incinerator residues	0	40	80	0	39	64	1.2
Sand and gravel	20	20	20	14	15	16	1.6
Total bulk specific gravity (t/m^3)	1.08	1.16	1.26	−	−	−	−
Volume of excavation (ton)	86400	92800	100800	−	−	−	−

Table 3 Calculation result of cost

Case / Treatment	Case-1	Case-2	Case-3	
	Fluidizing Gasification	Batch melting	Batch melting	Cement material after washing
Excavation, sorting, hauling	5600	5200	4800	1900
Melting treatment	9500	18100	23300	−
Cement material after washing	−	−	−	(45500～)65500
Total (JPN Yen / waste ton)	15100	23300	28100	(47400～)67400
Total (JPN Yen / waste m^3)	16300	27000	35400	(59700～)84900

Case-3, it could calculated as 23300 (JPN yen / waste ton) for the filled waste to include incineration residue.

6.2.3 Cement material after washing

For Case-3, it utilizes the filled waste including incineration residue mainly as a cement raw material after rough sorting and water washing, it calculated about 47400 to 67400 (JPN yen / waste ton). The price changes by undertaking costs of cement factory.

It will be possible for a judgment and evaluation of an economic effect of reproduction project by performance comparison with a rough estimation of reproduction project expense and a rough estimate of newly-built final disposal.

7. CONCLUSION

Following conclusions are made from this study:

1) For the proposed comprehensive technological system for reclaim landfill, if some technological applicability and influence which are mentioned above to neighboring environment are examined enough, it is possible that the system is able to introduce easily as a method of construction.

2) For time of planning and operation for project to reclaim landfills, it is similar mainly with a process of general project process, but it is appropriate method to reduce a risk to push forward a project step by step while conducting a necessary investigation.

3) For cost of the proposed system, it was thought that cost of reproduction of existing final disposal was larger than construction costs of new final disposal, but, it was clear that remarkable difference in cost was not seen.

ACNOWLEDGMENT

This study was compiled based on results of research of the research organization on reproduction technique of final disposal that the first author was concerned with greatly. We appreciate Dr. Ranjan Kumar Dahal of Tribhuvan University, Nepal for his comments in manuscript.

REFERENCES

Hachimura,T., Yamanaka,M., Hasegawa, S., and Ohno,H., 2009. Damage Survey and Disaster Wastes on the 2005 Fukuoka-ken Seiho-oki Earthquake, *Proc. of the 19th (2008) International Offshore and Polar Engineering Conference*, Osaka, Japan, pp.529-532 (Proceedings Article)

Higuchi, S., 2005. Development of a Comprehensive Technological System to Reclaim Landfills, *Waste Management Research*, The Japan Society of Waste Management Experts, 16(3):132-141.(in Japanese with English abstract, Journal Article)

Ohno,H., Tosaka,H., Hachimura,T., Miyahara,T., Matsumoto.K., Utsugi.K., Kitaoka,K., Yamamoto,A. and Yamamoto,T., 2008. Situation and Environmental Risk of the Waste at/after Disaster and the Tentative Waste Storage, *Proc. of APLAS Sapporo 2008, the 5th Asian-Pacific Landfill Symposium*, Sapporo, Japan: CD-ROM, 6p. (Proceedings Article)

Ono, S., 2000. Ground improvement and its Environmental impacts, *Journal of the Society of Materials Science*, Japan, 49(11): 1249-1254.(in Japanese, Journal Article)

Research organization on reproduction technique of final disposal, 2005. Report of research on reproduction technique of final disposal in FY 2004, Japan Environmental Sanitation Center (in Japanese)

Tanaka, M., 1999. Recent trends in recycling activities and waste management in Japan, *Journal of Material Cycles and Waste Management*, Springer, 1: 10-16. (Journal Article)

Waste and Recycling Division, Ministry of the Environment Government Japan, 2008. State of Discharge and Treatment of Municipal Solid Waste in FY 2006 (in Japanese)