

A STUDY ON BENEFIT AND COST EFFECTIVENESS OF CLOSED SYSTEM DISPOSAL FACILITIES

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SUMMARY: Closed System Disposal Facilities (CSDF) is intercepted by covering facilities and seepage control facilities from outside environment. For CSDF, covering facilities and incidental equipment are required, and there is an impression which construction costs of CSDF is high compared with conventional opened type landfill sites (OPLS). On the other hand, CSDF has the features, such as the ease of obtaining the consent of residents about the construction of a landfill site and conforming to various conditions of the location. About CSDF and OPLS, authors set up models, and examined the benefit and the cost effectiveness. By these examinations, the advantage of CSDF was confirmed. However, many bold assumptions were introduced into the examination process and this left some problems such as how to monetarize the benefits.

1. INTRODUCTION

The Research Committee for Closed System Disposal Facilities has proposed closed system disposal facilities (henceforth "CSDF") as landfill sites which can correspond to improvements in safety, environmental preservation functions, and information communication with residents, etc. An example of CSDF is shown in Figure 1, and the committee is currently performing an investigation, a study, and publicity work to increase the popularity of such facilities.

The CSDF, in which a landfill is covered with covering facilities, has the following features:

- It is easier to obtain the consent of residents about the construction of a landfill site.
- It can conform to various conditions of the location.
- A reduction of construction costs is possible by reducing the scale of water treatment facilities and maintenance management expenses.
- The scattering of waste and diffusion of bad smells can be prevented.



Figure 1. Examples of Closed System Disposal Facilities

- Neither the amount of leachate nor reclamation work is influenced by the weather.
- It can also be used as a storage facility for recycling.
- There is a wide variety of possible uses for the ultimate land.

Even though CSDF have such clear advantages, the factor of increased constructions costs due to the need for previously unnecessary (in the case of conventional opened type landfill sites (henceforth "OPLS")) covering and incidental facilities must be taken into account.

In this study, first models of CSDF and OPLS are set up and the construction costs of the main facilities are calculated. Second, the benefits obtained by building CSDF are examined. Finally, the advantages of building CSDF are confirmed by comparing the cost effectiveness of CSDF and OPLS.

2. MODELS OF CLOSED SYSTEM DISPOSAL FACILITIES AND CONVENTIONAL OPENED TYPE LANDFILL SITES

2.1 Specifications of Models

The models of CSDF (henceforth "Model CSDF") and OPLS (henceforth "Model OPLS") were set up to calculate the construction costs and the maintenance management costs. The specifications of Model CSDF and Model OPLS are shown in Table 1, and a cross-sectional view of Model CSDF (Case-1: 10,000m³) is shown in Figure 2.

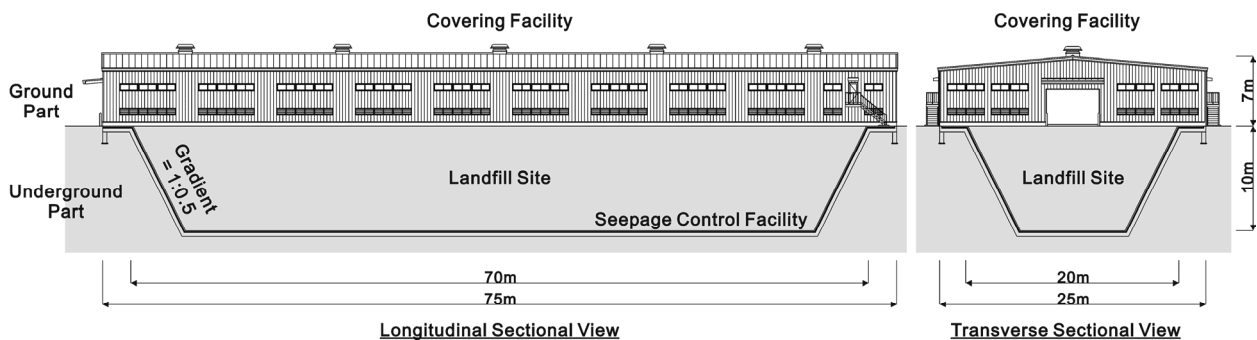


Figure 2. Cross-Sectional View of Model CSDF (Case-1: 10,000m³)

Table 1. Specifications of Models

		Case-1: 10,000m ³		Case-2: 50,000m ³	
		CSDF	OPLS	CSDF	OPLS
Reclamation capacity	(m ³)	10,000	12,000	47,000	56,400
Area of landfill	(m ²)	1,400	3,478	5,400	8,991
Width of landfill (earth surface)	(m)	20	47	60	81
Length of landfill (earth surface)	(m)	70	74	90	111
Width of landfill (bottom)	(m)	10	27	50	41
Length of landfill (bottom)	(m)	60	54	80	71
Gradient of slope of landfill		1 : 0.5	1 : 2.0	1 : 0.5	1 : 2.0
Depth of landfill	(m)	10	5	10	10
Capability of water treatment facility	(m ³ /d)	2.0	6.0	6.0	15.0

2.2 Calculation of Construction Costs

The principal facilities and equipment of landfills are as follows:

- Covering Facilities
- Equipment for Reclamation
- Lighting Equipment
- Watering Equipment
- Ventilation Equipment
- Seepage Control Facilities
- Water Treatment Facilities

The construction costs of the Model CSDF and the Model OPLS are shown in Table 2.

Table 2. Construction Costs of Facilities

		Case-1: 10,000m ³		Case-2: 50,000m ³	
		CSDF	OPLS	CSDF	OPLS
Covering Facilities	(yen)	78,000,000	0	230,000,000	0
Equipment for reclamation	(yen)	8,500,000	0	8,500,000	0
Lighting equipment	(yen)	5,320,000	0	20,160,000	0
Watering equipment	(yen)	6,800,000	0	24,000,000	0
Ventilation equipment	(yen)	2,200,000	0	3,300,000	0
Seepage control facilities	(yen)	111,018,000	68,363,000	240,203,000	180,472,000
Water treatment facilities	(yen)	139,000,000	300,000,000	300,000,000	571,000,000
Others	(yen)	70,700,000	115,614,000	283,100,000	429,083,000
Expenses	(yen)	105,385,000	120,994,000	277,316,000	295,139,000
Total	(yen)	526,923,000	604,971,000	1,386,579,000	1,475,694,000

Table 3. Maintenance Management Costs of Facilities

		Case-1: 10,000m ³		Case-2: 50,000m ³	
		CSDF	OPLS	CSDF	OPLS
Watering equipment	(yen/year)	120,000	0	312,000	0
Water treatment facilities	(yen/year)	5,800,000	9,600,000	9,600,000	18,100,000
Others	(yen/year)	12,000,000	14,400,000	56,400,000	67,680,000
Total	(yen/year)	17,920,000	24,000,000	66,312,000	85,780,000

2.2 Calculation of Maintenance Management Costs

The maintenance management costs of the Model CSDF and the Model OPLS are shown in Table 3.

3. EXAMINATION OF BENEFIT

In this chapter, the monetarization of the benefit of Model CSDF was attempted. The examination items regarding the benefit fall into four categories: Consensus Building, Maintenance Management, Environmental Management, and Land Utilization.

The items examined for each category are listed, and the results of the monetarization attempt are shown.

3.1 Consensus Building

The examined items and their contents regarding the benefits of consensus building are shown in Table 4.

Table 4. Consensus Building

Items	Contents of the monetarization (example)
Shortening of term	Number of times of local explanation meeting
Reduction of local measure costs	Construction of public hall, park, etc.
Improvement of scenery	Construction of periphery wall of landfill site
Flexibility of location	Construction of hauling road
Utilization of other facilities	Effective utilization of surrounding lifeline facilities
Existence of trial	Judicial costs
Consignment treatment of waste	Consignment treatment costs of waste until agreement

Table 5. Maintenance Management

Items	Contents of the monetarization (example)
Ease of reclamation work	Operation of reclamation work at the time of heavy rain and heavy snowfall. Snow removal costs and maintenance costs of roads.
Shortening of management term	Term from completion of reclamation to closure of landfill site
Management of facilities	Maintenance costs of covering facilities, seepage control facilities or water treatment facility
Measure of floods	Spillway for heavy rain, and construction of reservoir pond
Reduction of volume of cover soil	Volume of cover soil for scattering of waste and measure of coarse particulate

3.2 Maintenance Management

The examined items and their contents regarding the benefits of maintenance management are shown in Table 5.

3.3 Environmental Management

The examined items and their contents regarding the benefits of environmental management are shown in Table 6.

3.4 Land Utilization

The examined items and their contents regarding the benefits of land utilization are shown in Table 7.

Table 6. Environmental Management

Items	Contents of the monetarization (example)
Measure of scattering and coarse particulate	Construction of fence for measure of scattering
Measure of bad smell	The amount of spraying of deodorant or antiseptic
Measure of discharge of treated water	Compensation caused by discharging to fishery people and agricultural people caused by discharging
Damage to image	Fall of land prices of surrounding areas

Table 7. Land Utilization

Items	Contents of the monetarization (example)
Surrounding land utilization	Research expenditure of land utilization and compensation to surrounding land utilization being restricted
Ease of location selection	Cost for reservation of the substitute land for surrounding facilities and move
Reduction of design costs	Special design costs for geographical feature or geology
Ease of ultimate land utilization	Possibility of early land utilization, and utilization of facilities of landfill site

Table 8. Benefit of Model CSDF

Category		Monetarized Benefit	
		Case-1: 10,000m ³	Case-2: 50,000m ³
Consensus Building	(yen)	67,300,000	227,200,000
	(yen/year)	0	0
Maintenance Management	(yen)	0	0
	(yen/year)	1,968,000	8,280,000
Environmental Management	(yen)	59,100,000	66,200,000
	(yen/year)	225,000	1,125,000
Land Utilization	(yen)	20,532,000	46,005,000
	(yen/year)	0	0
Total	(yen)	146,932,000	339,405,000
	(yen/year)	2,193,000	9,405,000

3.5 Benefit of Closed System Disposal Facilities

It is difficult to monetarize the benefit of CSDF directly. Therefore, the costs for Model CSDF and Model OPLS were calculated for each category, and the difference was considered the monetarized benefit of Model CSDF.

However, "Flexibility of location" and "Measure of floods" were not included since benefit was defined as the difference of the construction costs of the landfill sites. Moreover, "Shortening of management term" and "Ease of ultimate land utilization" were not included since the benefit was obtained after completing the reclamation of waste.

The monetarized benefit of Model CSDF is summarized in Table 8.

4. EXAMINATION OF COST EFFECTIVENESS

In this chapter, the cost effectiveness of CSDF and OPLS was compared on the basis of the aforementioned results.

Table 9. Construction Costs and Maintenance Management Costs

		Case-1: 10,000m ³		Case-2: 50,000m ³	
		CSDF	OPLS	CSDF	OPLS
Construction Costs	(yen)	526,923,000	604,971,000	1,386,579,000	1,475,694,000
Maintenance Management Costs	(yen/year)	17,920,000	24,000,000	66,312,000	85,780,000

4.1 Calculation of Costs

Costs consist of the construction costs (Table 2) and maintenance management costs (Table 3) of facilities.

The calculated costs are shown in Table 9.

4.2 Calculation of Effect

In addition to the benefit examined for the preceding chapter, the following effect was taken into consideration in calculation of the effect.

- The effect of life preservation and difference of collection cost + haulage in comparison with the consignment of disposal of waste
- The effect of prevention of the pollution of groundwater and soil
- The effect of prevention of the scattering of waste and prevention of bad smell
- The effect of preservation of water quality of the public water area

The calculated effect is shown in Table 10.

Table 10. Calculated Effect

		Case-1: 10,000m ³		Case-2: 50,000m ³	
		CSDF	OPLS	CSDF	OPLS
Benefit of Model CSDF	(yen)	146,932,000	0	339,405,000	0
	(yen/year)	2,193,000	0	9,405,000	0
Effect of life preservation	(yen/year)	32,680,000	32,680,000	99,940,000	99,940,000
Difference of the collection cost + haulage of waste	(yen/year)	4,398,000	3,298,000	31,006,000	20,671,000
Effect of prevention of pollution of groundwater and soil	(yen)	131,731,000	151,243,000	324,770,000	325,174,000
Effect of prevention of scattering of waste and prevention of bad smell	(yen/year)	9,150,000	27,300,000	21,375,000	64,125,000
Effect of preservation of water quality of public water area	(yen)	4,480,000	6,000,000	16,578,000	21,445,000
Total	(yen)	283,143,000	157,243,000	702,628,000	390,369,000
	(yen/year)	48,421,000	63,278,000	161,726,000	184,736,000

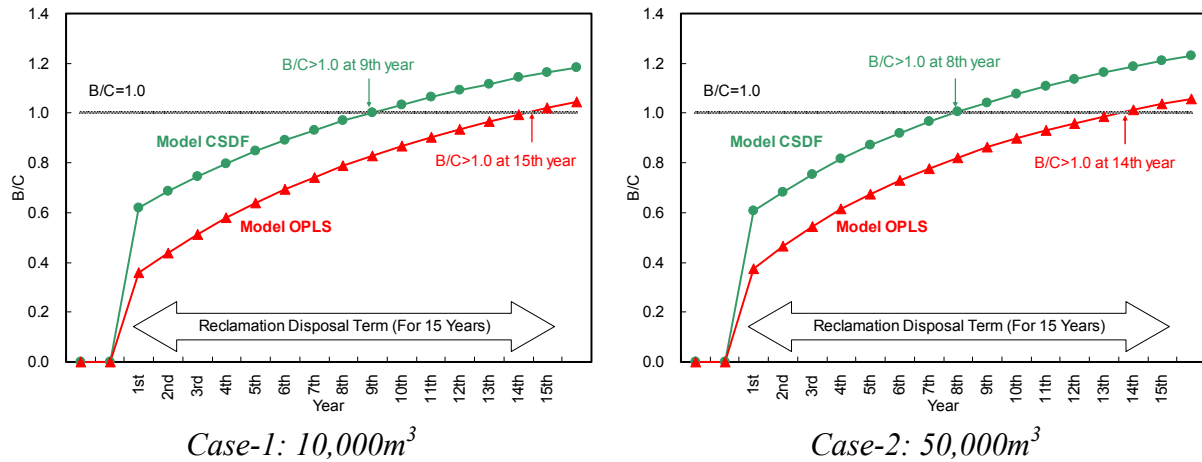


Figure 3. Comparison of Cost Effectiveness

4.3 Comparison of Cost Effectiveness

The cost effectiveness of Model CSDF and Model OPLS was compared using the results of the foregoing paragraphs (Figure 3).

In the case of Case-1 (10,000m³), because B/C exceeds 1 during the reclamation, sufficient cost effectiveness can be expected regarding both of the landfill sites. However, it is in the 9th year that B/C exceeds a value of 1.0 in Model CSDF after reclamation starts, while it is in the 15th year in Model OPLS. Therefore, in this examination condition, it turns out that Model CSDF is advantageous with respect to cost effectiveness.

And the result is same in the case of Case-2 (50,000m³).

5. CONCLUSIONS

Models of CSDF and OPLS having 10,000m³ or 50,000m³ disposal capacity were set up, and construction costs and maintenance management costs were calculated. Moreover, the benefit of constructing CSDF was examined, and the cost effectiveness of CSDF and OPLS was compared. The advantages of CSDF were confirmed by these results.

However, a bold assumption was introduced through the setup of models, the calculation of construction costs and maintenance management costs, and the monetarization of the benefit. Although the examination in this study is very useful in order to understand the advantages of CSDF over OPLS, more detailed studies are necessary in the future.

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