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Problems and Improvement of the Construction & Demolition Waste Management System-Focusing on the Case of Seoul

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Abstract

Since C&D waste consists of various properties, the importance of eco-friendly treatment through separation and discharge according to the source is increasing. In Korea, C&D waste is called Total construction wastes (TCW), It is classified as construction waste (CW) with an amount of more than 5 tons, and construction site household waste (CHW) with less than 5 tons. Recently, it has been confirmed that most of CHW are simply incinerated or landfilled due to not properly management. However, there is only one case in Korea that classifies CHW, and since it is small compared to CW, there has been no case of research related to construction waste.

In this study, the management status of TCW was diagnosed using Seoul as a case, and problems and improvement were reviewed the management of CHW. In the current management system of CHW, it is impossible to identify the amount of waste generated and induce separate discharge, and most of it is mixed and discharged and landfilled. To improve these problems, a separate discharge method for each type of CHW, establishment of discharge reporting system, installation of public sorting centers for each autonomous district, and a total volume system for loading into landfills were proposal. Through this improvement, it will be possible to establish statistics that can identify the generation and treatment amount of CHW, and it will be possible to establish a management plan based on these statistics. In addition, it will be possible to manage and supervise the separate discharge and reduce the amount of mixed CW as the public sorting facility is expanded and the amount of landfill is limited. In addition, by sharing Korea's construction waste management cases, it can be used in a system that can efficiently manage construction waste in various countries.

Introduction

As the economy grows, cities are newly developed to improve the quality of life, and aging houses are being improved and reconstructed, the construction industry continues to grow worldwide [1]. A large amount of C&D waste is generated in the process of the construction industry, demolition waste constitutes a larger portion of C&D waste [2]. the total amount of C&D waste generated worldwide every year exceeds 10 billion tons, of which about 700 million tons in the United States and 800 million tons in the EU [3]. Various environmental impacts related to the generation and disposal of C&D waste are a global problem [4,5]. C&D waste decrease the consumption of primary raw materials and the emission of greenhouse gases (GHG) [6], They turned this potential into strategies, action plans and legislations, based on sustainable development goals (SDG). In Korea, C&D waste is classified as construction site household waste (CHW) if the amount is less than 5 tons, and construction waste (CW) if it is more than 5 tons. CHW as household waste, the local government has the responsibility to dispose of it, and for CW as industrial waste, the discharger is responsible for the disposal [7].

Korea's TCW generation per GDP is the second highest among Hong-Kong, Japan, Singapore [8]. In Korea, CW generated 86.44 million tons and CHW 530,000 tons as of '20, and the recycling

rate of CW is very high at 99.0%, but the recycling rate of CHW is only 5.4% [9,10]. This suggests that there are problems with the discharge and treatment system of CHW. Recently, With the closure of businesses due to COVID-19, industry conversion is underway and housing improvement projects installed in the 80-90s are progressing, CHW is rapidly increasing. CHW is not treated through segregation, the boundary between CW and CHW is ambiguous, and CW is disguised as CHW and discharged, making it difficult to manage TCW. This is because recycling may become difficult if they are mixed at the discharge stage [11]. CW consists of mineral waste (concrete, brick, etc), other mineral waste (sand, soils ,etc.), glass and wood waste, metal (ferrous and non-ferrous), soils and plastic, paper [12]. If the construction waste is discharged without separate discharge (combustible, non-combustible), It flows into the incineration facility with a large amount of combustible and non-combustible increase the processing load of the incineration facility and the amount of incineration ash generated [13]. Also, it can reduce the life of the landfill by being brought into the landfill with combustible [14]. Due to this problem, there is a recent demand for an improvement plan for the management system of CHW in Korea, and this study analyzes the management status of TCW using Seoul as an example. In particular, the improvement of the management system was reviewed, focusing on CHW.

Method

Waste definition

This study aimed to analyze what is classified as construction waste in the waste classification system of Korea's Waste Management Act. To clarify the terminology and prevent confusion in the description, all wastes generated in the process of construction work are referred to as total construction wastes (TCW). Among them, wastes generated more than 5 tons from construction start to completion was defined as construction waste (CW), and waste generated less than 5 tons was defined as construction site household waste(CHW). In the description process, abbreviations are used to explain.

Analysis of management status of total construction waste in Seoul

The management status of TCW was analyzed as a case study in Seoul. In Korea, it is mandatory for discharge of CW to report the amount of waste generated. To analyze the status of CW generation and treatment, CW discharge data (2019), which is managed statistically by the Waste Electronic Handover System (Allbaro System) managed by the Korea Environment Corporation(K-eco), was used. Of the construction waste discharge data, only the amount of construction waste generated by the construction carried out by Seoul was used.

CHW is discharged and disposed of through the collection and transport route of the local government, or most of it is brought into temporary storage places managed by the local government. The generation and disposal of CHW was calculated using the results of carrying out and reporting ('18~'20) of temporary storage places installed in the city's jurisdiction. However, since the CW and CHW are stored together in the temporary storage, it is difficult to determine the amount of CHW. Therefore, from the TCW discharge performance of Seoul, the remaining amount excluding the amount of CW brought into temporary storage was used as the amount of CHW

Consideration of Seoul's improvement for the separation discharge system at CHW

In Seoul, CHW is continuously increasing, and it is necessary to manage it in terms of resource circulation. A clear management system is required because the local government is responsible for disposing of CHW as household waste. Through the analysis of the management system of construction waste, problems were derived in the treatment process, and improvement measures were reviewed for each problem. The subjects of review were statistical improvement on the generation and treatment of construction waste, improvement of the separate discharge system at the discharge stage, and improvement plans for facilities for each type of waste discharged. A specific methodology for establishing the above improvement system was presented.

Results and Discussion

Status of generation and treatment of TCW in Seoul

CW generated in Seoul is 13.12 million tons/year, and all of it is consigned to an intermediate treatment company for construction waste. When brought into an intermediate treatment company, most of them are exported as aggregate, sand, waste soil, etc. (12.71 million tons/year, 97.0%) through mechanical treatment such as separation, sorting, and crushing, and valuable substances are recycled (0.109 million tons /year, 0.8%), combustibles are incinerated (0.016 million tons/year, 0.1%), and the remaining contaminants are treated in landfill (0.275 million tons /year, 2.1%). Although the statistics are not accurate because the amount of CHW is mixed with CW, the amount of CHW in 2019 was 865,657 tons of 446,182 tons/year (the amount of CW reported as construction waste is 419,475 tons, so 446,182 tons of household waste at construction sites is applied. ton).

Among them, 36.31% is landfill, 0.30% is incinerated, and 63.39% is recycled. It can be confirmed that the landfill ratio is higher than that of construction waste (CW), and this is because there is no standard for sorting, dismantling, and separate discharge in the discharge stage, so it is not recycled, and most of it is generated in a mixed form (Table 1&2). CW are managed by the waste tracking system (Called Allbaro System) from the discharge stage to the final disposal stage, and there are few landfill wastes because sorting and dismantling are mandatory. On the other hand, CHW are mixed and discharged due to the absence of management guidelines and are being landfills. Recently, it is difficult to secure a landfill site, so a zero-reclamation policy has been established, but it is aggravating the difficulty in securing the effectiveness of the policy for such CHW. Since landfill is no longer possible, and even intermediate treatment generates fine dust and entails additional costs, it is necessary to activate recycling through pre-sorting [15].

Table 1: Discharge by type of TCW in Seoul.

Category	TCW (A+B)		CW (A)		CHW (B)	
	Amount (ton/year)	ratio (%)	Amount (ton/year)	ratio (%)	Amount ratio (%) (ton/year)	ratio (%)
Concrete	9,616,473	70.94	9,411,408	71.79	205,065	45.96
Soil and stone	652,447	4.81	652,447	4.98	0	0.00
Plastic	58,780	0.43	33,704	0.26	25,075	5.62
Wood	131,894	0.97	71,214	0.54	60,681	13.60
mixed waste	1,715,724	12.66	1,560,720	11.91	155,004	34.74
Other	1,380,385	10.18	1,380,073	10.53	312	0.07
Total	13,555,747	100%	13,109,565	100	446,182	100

Table 2: Status of treatment by type of TCW in Seoul.

Category	TCW (A+B)		CW (A)		CHW (B)	
	Amount (ton/year)	ratio (%)	Amount (ton/year)	ratio (%)	Amount ratio (%) (ton/year)	ratio (%)
Landfill	436,972	3.22	274,963	2.10	162,009	36.31
Incineration	17,411	0.13	16,073	0.12	1,339	0.30
recycle	391,609	2.89	108,774	0.83	282,835	63.39
Other	12,709,756	93.76	12,709,756	96.95		-
Total	13,555,747	100	13,109,565	100	446,182	100

Management actual situation of construction waste in Seoul

In Korea, construction waste is induced to separate and dispose of 14 types of construction waste before dismantling. Among the classified and dismantled construction wastes, those that can be self-supporting by material are consigned to recycling companies, and those requiring reprocessing such as concrete are consigned to construction waste intermediate processing companies. On the other hand, there is no standard for classification and dismantling for construction site household waste or building demolition work with a total floor area of less than 500m2 and it is generally generated in a mixed form during the dismantling process and transported directly or consigned to an unauthorized disposal company to temporarily dismantle construction waste.

However, it is difficult to collect statistics because the discharge of CW and CHW are mixed, and it is also a starting point for illegal treatment. Even if CW flows into a public sorting site, it cannot be managed, increasing the burden of CHW treatment on local governments. Conversely, as CHW flows into temporary storage, the properties of construction waste deteriorate, making it difficult to recycle CW (Figure 1&2).

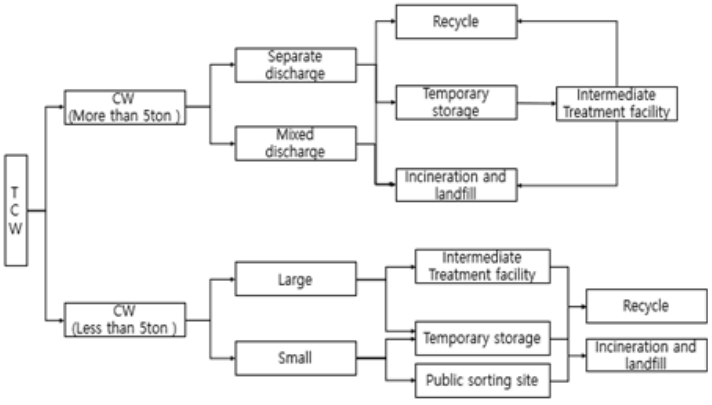

Figure 1: Total Construction Waste Management Flow Chart in Seoul.

Problems in the management of CW in Seoul

CW enacted "the Act on Promotion of Recycling of Construction Wastes" in 2003, reorganizing related guidelines, etc. and managing them appropriately. However, CHW became a problem in the process of analyzing the factors of increase in landfill waste, which led to the demand for improvement of related laws and systems from 2019. As for CW, as the discharger is obliged to report it in the Allbaro system, the amount of waste and the amount of waste are managed. However, CHW is not managed by local governments as household waste, and there is no system for reporting discharger and treatment as industrial waste. Due to this, it is difficult to

induce selective dismantling and separate discharge at the stage of CHW discharge, and there are structural limitations that cannot prevent illegal disposal such as illegal dumping and mixing of CW. In addition, since it is not possible to determine the exact amount of waste generated, it is difficult to establish a management plan for CHW or to calculate the capacity of public sorting sites and related facilities to deal with them.

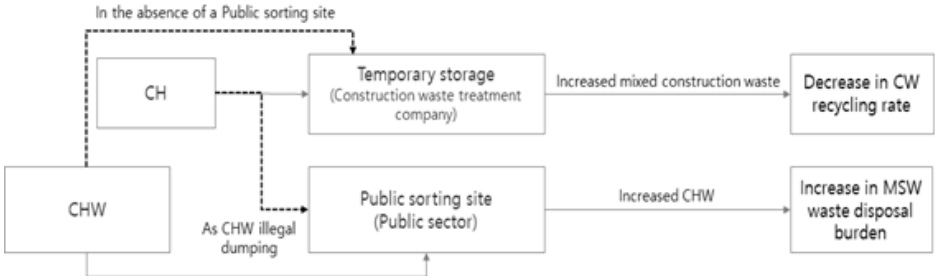

Figure 2: The status of disposal of CHW.

Recently, the treatment status of CHW in Seoul shows that recycling is increasing, and incineration and landfill are decreasing. In order to achieve zero landfill, material recycling and energy recycling are being promoted by separating and discharging in advance. As can be seen from the generation and treatment status of CW, It has a high rate of generation of waste concrete, which is easy to recycle, at 71.94%, and the proportion of mixed construction waste is as low as 11.91%, whereas CHW has a high proportion of mixed construction waste. This is as high as 34.74%. In other words, it is difficult to reselect mixed construction waste in the treatment stage, and the landfill ratio is high (Table 1). The reason for the high proportion of mixed construction waste in CHW is that the waste generated during the extension and renovation of buildings is not separated and discharged. It is confirmed that this is because there are limitations. Although the landfill proportion of CHW shows a decreasing trend, the landfill proportion is 36.31%, which is higher than the 2.10% CW (Figure 3).

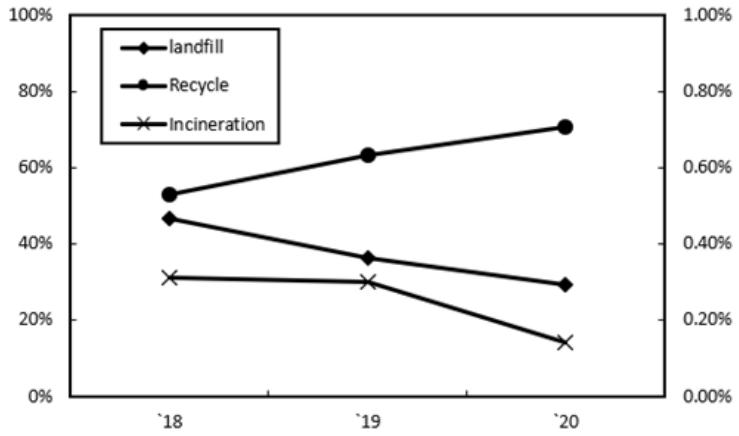

Figure 3: Changes in the proportion of CHW processing in Seoul.

Improvement for Seoul's CHW management system

The improvement measures for the above-mentioned problems in the management system of CHW were classified into five types according to the treatment flow of CW and improvement measures were presented (Figure 4). The basis of the improvement is to achieve zero landfill through the expansion of recycling of wastes by sorting and dismantling, separate discharge. In other words, it is to minimize the amount of landfill by recycling and incineration at the waste management area of the local government through separate discharge at the site.

First, the CW and CHW standards of 5 tons are downgraded so that local governments can manage their waste treatment systems. The second is to reorganize the discharge reporting system in the same way as the existing large-scale waste reporting system to manage the discharged waste. Third, thorough separation of waste generated during the construction process, fourth, collection, transportation, storage, maintenance of simple crushing facilities, and fifth, burial of combustible waste is prohibited. Implementation of the import volume system.

Downgrading the standard of 5 tons of CW to less than 1.5 tons

The standard of "waste generated by 5 tons or more from a series of construction works" set to manage CW is the standard set in the 1990s. An important fact is that it is difficult to manage CHW that is less than 5 tons by this standard. It is necessary to induce the private sector to manage waste over a certain amount, and to lower the amount to a manageable amount as domestic waste by

the local government. CHW can be classified into non-combustible and combustible, and non-combustible has a density of 1-1.5 ton/m3 and flammability is 0.1-0.4d ton/m3 although there are many differences between types. Volume-based bags cannot be used because they have a certain volume and contain a large amount of non-combustible material that cannot be incinerated. The volume-based waste fee system enforcement guidelines stipulate that the discharge density of waste is 0.25 kg/L or less.

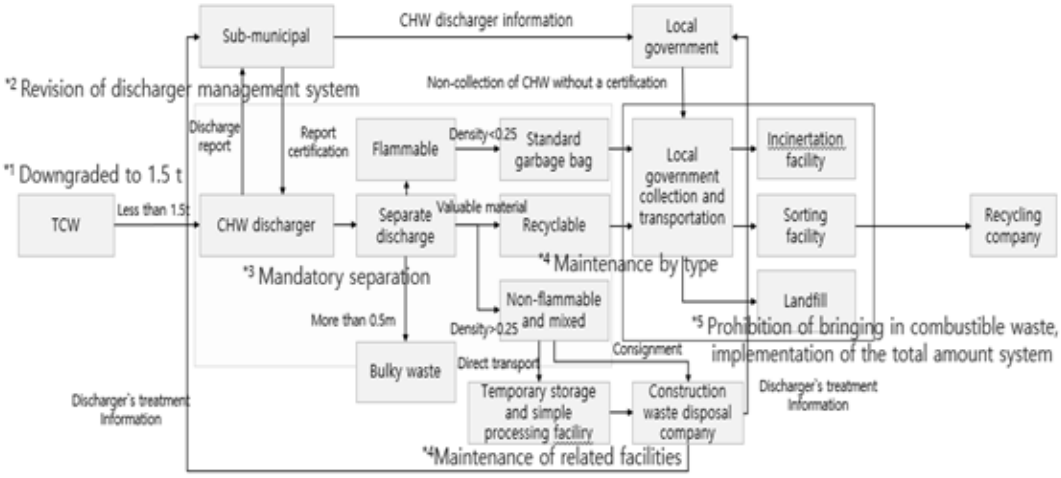

Figure 4: Scheme of CHW management system improvement.

In order to lower the regulatory value to a range that discharger and local governments can manage, it is suggested that the value be less than 1.5 tons. The rationale for this is that it is possible to dispose of incombustibles in dedicated sacks and inflammables in large volume-based bags. This is because the amount can be brought into the temporary storage of local governments (Figure 5).

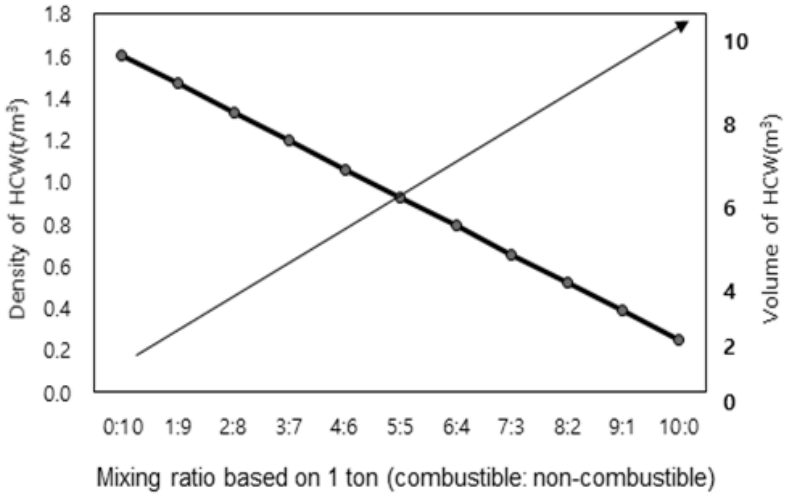

Figure 5: Density and volume according to the mixing rate of CHW.

Maintenance of discharger management (reporting) system

There is no statistical management on the amount of CHW generated by each autonomous district. It is necessary to establish a discharge reporting system to block the possibility of illegal dumping in advance and establish a statistical system for CHW discharge by tracing the entire waste process from discharge to disposal. In terms of minimizing the initial investment cost and improving the convenience of use by civil servants, it is possible to consider establishing a system like the large-scale household waste report. A method of using a platform such as a large-scale waste discharge registration system can be considered. In this case, the benefits such as budget savings and operational burden reduction for each district and the entire city of construction waste data in Seoul as all autonomous districts use the same format data It is expected that there will be advantages in aggregation, analysis, and utilization.

It can be composed of a total of three methods: discharging directly to an intermediate treatment company, discharging through temporary storage, or discharging to special sacks. It is necessary to organize the data system by dividing the data

tables by flow of "Report/Approval → discharge/Collection → Statistical Management" and arranging necessary data items and information in each table. When reporting a discharger, the name of the discharger, address, contact. However, in consideration of administrative efficiency, it is difficult to manage all targets, so it is necessary to operate the discharge reporting system only when the discharge is above a certain amount. As for the target, mass discharge is the target, but it will be necessary to prepare an objective standard for that standard. In the case of mass discharge, it will be possible to operate the discharge reporting system through a system that confirms proper discharge through detailed guidance before construction and work start and guidance and inspection before and after construction by making it mandatory to fill out a sales ledger at the volume-based bag sales office.

For the efficiency of CHW and CW treatment, discharge by type is important [16]. Wastes that are difficult to put in the volume-based waste bags are classified as oversized wastes as much as possible and collected, and recyclables or combustible/non-combustible wastes that are not classified as oversized wastes are discharged in separate PP bags and sacks produced and sold by local governments. Large household wastes such as furniture generated in autonomous districts are collected and transported through private agencies that have signed an agency contract with the autonomous district after the complainant reports the discharge and discharges it to a designated place. The transported large-scale household waste is processed by a specific treatment company after simple processing such as sorting and shredding at the large-scale household waste transfer center in the autonomous district. Wastes that are treated as large household waste discharge items such as sinks, wood items, furniture, doors, washbasins, toilets, carpets, lighting fixtures, etc. from interior construction, etc. are separated and sorted at CHW and treated according to the large household waste discharge and collection system. It is possible to promote recycling of household waste and induce weight loss.

Recycling wastes generated in autonomous districts are collected and transported through the direct management of the autonomous districts or private agencies, then collected and sorted at the autonomous district recycling sorting site, and then sent to a recycling and recycling company for final treatment. CHW also contains recyclable wastes such as metals, plastics, and paper (packaging materials, etc.), so it is possible to promote the recycling of CHW by going through the separation and sorting process and treating it according to the current autonomous district recycling system.

Combustible wastes are put in a volume-rate disposal bag in each autonomous district and are incinerated at public or private incineration facilities through a collection system. Combustible wastes such as waste wallpaper and waste films mixed with CHW can also be separated, discharged, or separated and sorted, put in a volume-rate disposal bag and incinerated in the same way as the current combustible waste treatment method, to induce a reduction in landfill waste at construction sites. According to the construction waste classification system, waste wallpaper and waste synthetic resin (including waste film) are classified as combustible waste and can be recycled or incinerated depending on whether it is recyclable or not, and if incineration is not possible, it can be entrusted to a landfill company. Waste collected in volume-based bags is transported to the resource recovery facility in the area where the resource recovery facility is installed, and to the intermediate collection point in autonomous districts where it is not, compressed and transported to the metropolitan landfill site through a large transport vehicle or does not go through the intermediate collection station. Instead, it is transported directly to landfill by compression vehicle and disposed of. The importation of waste and vehicle registration must be submitted to the corporation by the city, county, or Gu office, and the importation of landfill waste must be managed.

Non-combustible waste, which is difficult to recycle, falls under the target of landfill CHW, and it is necessary to discharge and dispose of it by classifying collection and transportation methods according to the amount (large amount/small amount) generated. Since the method of discharging large and small amounts of non-combustible waste has been established, if some improvements are made to the current system to minimize confusion due to changes, the current discharge method will be applied mutatis mutandis, and large amounts will be transported directly by interior companies, etc. according to the amount of CHW generated. Small amounts are placed in special sacks and discharged through the autonomous district large-scale waste discharge and collection system. In this case, the large amount of CHW is discharged to landfills after separation and sorting at the self-governing district public sorting center or private temporary storage place designation company.

Installation of related facilities (Temporary storage, public sorting facility) for each autonomous district

In the case of a small amount of CHW in Seoul, it is directly processed through special sacks for each autonomous district, but in the case of a large amount of CHW, which accounts for most, it is processed through temporary storage. However, the current temporary storage place is not being operated through a facility management contract with the autonomous district, but is operated autonomously by a private company, so it is not being used in accordance with the meaning of the public sorting place stipulated in the "Guidelines for the Volume-based Waste Fee System". In line with the purpose of the Volume-based Waste Fee System Implementation Guidelines, it is necessary to secure a site for each autonomous district and install and operate a new public sorting facility. This is a method that exactly matches the purpose of the Waste Management Act, which places the responsibility of municipal waste treatment on local governments by converting CHW, which is currently being treated in the private sector, to a process in the public sector.

By operating public sorting centers for each autonomous district, it is possible to properly and legally treat household waste from construction sites, maximize the effect of preventing environmental pollution, and respond thoroughly and promptly to civil complaints. On the other hand, since almost all autonomous

districts in Seoul are close to population, it is virtually difficult to secure a site of a certain size. Therefore, in principle, it is a rule to install public sorting centers for each autonomous district, but the conventional temporary storage is designated as the CHW public sorting site only in cases of unavoidable circumstances, Facilities should establish a plan to expand public sorting centers in a way to minimize the impact on residents through indoor and underground construction.

Reinforcement of regulations on landfilling of CHW

To achieve zero landfill while inducing recycling of CHW, only separated and sorted waste should be landfilled. Most of CHW's loading into landfills is unsorted mixed waste, and it is a measure to regulate the mixed amount of combustible waste to regulate the entry of mixed waste. Since the amount of combustible waste can be easily measured, it is expected that the amount of mixed waste will be reduced when the content is regulated to only 3-5%. In addition, the total amount should be determined by agreement between the CHW processing company and the Seoul Metropolitan Government, and the company's facility improvement should be strengthened to ensure compliance with the total amount brought into the metropolitan area landfill site. To this end, we maximize the reduction in the amount of landfill or incineration waste by creating a sales ledger for exclusive non-combustible exclusive PP bags and reporting 10 or more discharges, and by establishing separate discharges by nature through prior guidance on prohibited acts under laws and regulations. The total amount should be determined through an agreement between the import processing company and the autonomous district, and the company should comply with the total import volume system by strengthening selection through facility improvement, etc.

Conclusions and Remarks

This study drew a plan to improve the management system of CHW among TCW using Seoul as a case, and the results are as follows. TCW is divided into CHW and CW based on 5 tons. As of 2019, the amount of TCW generated in Seoul was 13.56 million tons, with CW accounting for 96.7% and CHW accounting for 3.3%. CW has a high recycling rate due to its high separation and dismantling and concrete composition, whereas CHW has a high proportion of mixed construction waste or difficult-to-recycle properties, so it cannot be recycled and is being disposed of in landfill. The problems of CHW management in Seoul were derived and improvement measures were suggested as follows.

First, it is necessary to downgrade the quantitative standard for CHW, currently set at less than 5 tons, to 1.5 tons. The regulatory standard of 5 tons has lost its basis and needs to be adjusted to a manageable range by the emitter and local government. Second, in the discharge stage, recycling should be activated through thorough separation and discharge, combustibles should be incinerated, and only non-combustible materials should be landfilled to induce zero landfill. Third, it is impossible to identify the emitter of the construction waste, and it is difficult to estimate the amount of waste generated, so there is a limit to establishing a management plan and establishing a treatment system. It is necessary to reorganize the emission reporting system so that the generation and treatment route can be identified, and the emission control principle is applied. Fourth, there are few public sorting sites that can process CHW, so it is mixed with construction waste from temporary storage and brought in. As a result, counting and sorting the amount of CHW is not being performed. Therefore, the Seoul Metropolitan Government establishes a plan to install public sorting centers for each autonomous district to deal with CHW and converts temporary storage into public sorting centers in case of emergency. Fifth, the prohibition of direct landfilling of combustible wastes and the total volume system were proposed to regulate waste brought in from landfills to induce recycling. To encourage recycling of construction waste treatment companies, it is necessary to fundamentally reduce the amount of landfill and implement the CHW import volume system at landfills in the metropolitan area.

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