Unit Generation Rate of Construction & Demolition Debris due to Construction Activities

H.S. Lee, J.W. Kim,

J.G. Choi, H.L. Jung, Y.H. Kang,
S.K. Choi, S.J. Lee

Korea Environment Institute

Introduction

Recent active development plan by local & central government/private company

→ The reported amount of C&D debris has sharply increased by 10 ~ 30% annually during last 10 years.

→ C&D debris occupies above 50% of wastes carried in landfill site in metropolitan area.

Unique characterization of C&D debris

→ High possibility of recycling such as waste-concrete and waste-asphalt concrete.

→ Required Recycling technologies and facilities are easy to be achieved.

Introduction

Current recycling status of C&D debris in Korea

→ Most of recycled aggregates are used for low value added materials only for filling & covering material.

→ Recycled aggregates are not used for highly value added materials such as road base material.

→ Separate discharge is not actively practiced at the construction site.

: Lots of mixed wastes are discharged, and they are negatively affect the quality of recycled aggregates.

→ Main categories are not confirmed to set the guidelines for separate discharge.

→ Unit generation rates for estimating the amount generated & considering separate discharge are not determined.

Introduction

Aims

→ Various C&D debris generated at the construction site should be combined into some categories which can be easily controlled at construction site.

→ New components of C&D debris categories should be defined for promoting separate discharge.

→ Unit generation rates are essential data to estimate C&D debris generated in various EIA project and prepare for effective management system for C&D debris recycling.

Therefore, unit generation rates with new C&D debris categories should be determined to effectively manage the C&D debris at construction site.

Various C&D debris

Typical components and main discharge site of C&D debris

Main discharge site	Contents example
Road works	Asphalt concrete, concrete, rock, earth, wood
Construction works Renovation Development project Excavation works Framework construction Closing works Etc	Concrete, aggregates, rock, earth pipes, rebar, flashing, steel, aluminum, copper, brass, stainless steel forming and framing lumber, stumps, plywood, doors, window frames, scarps plastics (vinyl siding), glass (windows, mirrors, lights), miscellaneous (carpeting, fixtures, insulation, ceramic tiles) bricks (bricks and decorative blocks), slate, blocks, mortar etc

Categorization of C&D debris

Basic concept

→ To achieve and promote effective C&D debris management considering waste recycling, categorization of C&D debris is required.

→ C&D debris recycling is mainly focused on waste-concrete and waste-asphalt concrete.

: Other wastes which negatively affect the quality of recycled aggregates should be categorized as one item.

: Combustible wastes should not be carried into landfill site for proper treatment so that it should be categorized as one item.

→ The number of C&D debris types should be adequate, because preparing enough space for separate discharge of detailed types at construction site is normally impossible.

Categorization of C&D debris

Main discharge site	Contents example	Main component
Road works	Asphalt concrete, concrete, rock, earth, wood	Asphalt concrete Concrete Metals Wood Combustible wastes Incombustible wastes
Construction works Renovation Development project Excavation works Framework construction Closing works Etc	Concrete, aggregates, rock, earth	
	Pipes, rebar, flashing, steel, aluminum, copper, brass, stainless steel	
	Forming and framing lumber, stumps, plywood, doors, window frames, scarps	
	Plastics (vinyl siding), miscellaneous (carpeting, fixtures, insulation, ceramic tiles)	
	Bricks (bricks and decorative blocks), slate, blocks, mortar, glass (windows, mirrors, lights), etc	

Unit generation rates

Two methods to obtain generation rates of C&D debris

Methods		Advantages/Disadvantages
Direct method	Actual measurement	- The data for total amount of C&D debris are the most accurate. - Time and labor consuming method. - It is not easy to estimate the each type of C&D debris when mixed construction wastes are discharged.
Indirect method	Calculating amount of C&D debris by using additional material rate data	- Amount of C&D debris can be estimated in accordance with each construction site. - There will be a gab between actual amount of C&D debris generated and estimated amount. - It is not easy to apply precise additional material rates or weight conversion factors according to each construction material.
	Using, collecting and analyzing data presented at previous reference	- Various references can be used. - Different reference generally shows different generation rates. - It is not easy to estimating amount according to construction type and construction structures.

Unit generation rates

Typical references to describe the unit generation rates

Direct method

1. A research on Bucheon-Sangdong region by Korea land corporation

2. Construction standard material estimation data (only for private residents and apartment building)

3. Unit generation rates for each construction types by Seoul metropolitan development corporation

Indirect method

1. Construction standard material estimation data (others except for private residents and apartment building)

2. A reference by Seoul development institute

3. A reference by Asia pacific environment & management institute

4. A reference by Korea national housing corporation technology (Apartment only)

Reviewing references of unit generation rates

Problems of previous references

→ C&D debris categories are not generally fixed; therefore, different research & reference have own categories when determining the unit generation rates.
: Each previous reference has nothing in common about building types & C&D debris types.

→ A data obtained from actual measurement (direct method) could not be generally used since actual measurement data usually focus on the total amount of C&D debris and reconstruction site for old types of private residents houses.

→ All of previous research didn't consider the separate discharge; therefore, C&D debris categories is too simple or too detailed.

Reviewing references of unit generation rates

A : Construction standard material estimation

B : Asia pacific environment & management institute

C : Seoul development institute

Comparing building types

Reference	Building types								
A	Resident building			Office building			Public building		
	Private resident	Apartment		Steel	Reinforced concrete	Steel Reinforced concrete	Steel	Reinforced concrete	Steel Reinforced concrete
B	Steel reinforced concrete		Reinforced concrete		Steel		Brick		Wood frame
C	Resident building			Office building			Public building		
	Brick	Wood frame	Reinforced concrete	Steel	Reinforced concrete	Steel Reinforced concrete			

Reviewing references of unit generation rates

A : Construction standard material estimation

B : Asia pacific environment & management institute

C : Seoul development institute

Comparing types of C&D debris

Reference	Types of C&D debris							
A	Concrete	Metals	Mixed wastes					
B	Concrete	Metals	Glass	Paper	Plastics	Wood	Fiber	etc
C	Concrete	Metals	Glass	Paper	Plastics	Wood	Fiber	etc

Determination of unit generation rates

A method of determining unit generation rates

- Much portion of C&D debris are generated at demolition sites, and data from Construction standard material estimation are the most accurate in total amount generated. Therefore, total amount should be reflected by those data.
- But the categories are too simple to promote separate discharge.

: The generation rates of concrete and metals could be used.

: Mixed wastes should be broken down into 4 other components, that is asphalt concrete, wood, combustible wastes, incombustible wastes.

: Combustible wastes : paper, fibers, plastics, etc

Incombustible wastes : bricks, blocks, slate, mortar, tiles, and glasses

Determination of unit generation rates

A method of determining unit generation rates

- The building types of Asia pacific environment & management institute are not matched with CSME's types, so those data could not be considered in determining unit generation rates.

: Those basic ratio of C&D debris except concrete and metal can be obtained from data of Seoul development institute which is similar in building types with CSME's data.

→ If these ratio is applied to the amount of mixed wastes from CSME's data, mixed wastes could be broken down into four components.

Unit generation rates (Proposed)

Unit generation rates of construction sites in new construction **(Kg/m²)**

New construction		Concrete	Asphalt concrete	Metals	Wood	Combustible wastes	Incombustible wastes	Total
Resident building	Private resident	18.00 (69%)	-	1.60 (6%)	1.07 (4%)	1.74 (7%)	3.59 (14%)	26.00 (100%)
	Wood frame	- (0%)	-	2.20 (8%)	13.00 (50%)	1.50 (6%)	9.36 (36%)	26.07 (100%)
	Apartment	25.96 (89%)	-	0.05 (< 1%)	1.69 (6%)	0.07 (<1%)	1.47 (5%)	29.24 (100%)
Office building	Reinforced Concrete	19.00 (68%)	-	2.40 (5%)	1.31 (5%)	2.70 (10%)	2.39 (9%)	27.80 (100%)
	Steel	12.00 (59%)	-	1.80 (6%)	1.28 (6%)	2.32 (11%)	2.80 (14%)	20.20 (100%)
	Steel Reinforced Concrete	21.00 (65%)	-	4.00 (3%)	0.97 (3%)	3.23 (10%)	3.00 (9%)	32.21 (100%)
Public building	Reinforced Concrete	18.00 (62%)	-	2.20 (6%)	1.80 (6%)	3.71 (13%)	3.29 (11%)	29.00 (100%)
	Steel	12.00 (62%)	-	1.80 (6%)	1.12 (6%)	2.03 (10%)	2.45 (13%)	19.40 (100%)
	Steel Reinforced Concrete	18.00 (65%)	-	4.00 (3%)	0.76 (6%)	2.51 (9%)	2.33 (8%)	27.60 (100%)

Unit generation rates (Proposed)

Unit Generation rates of construction sites in demolition (Kg/m²)

Demolition		Concrete	Asphalt concrete	Metals	Wood	Combustible wastes	Incombustible wastes	Total
Resident Building	Private Resident	1409.00 (85%)	-	48.00 (3%)	11.17 (1%)	10.15 (1%)	181.62 (11%)	1659.94 (100%)
	Wood frame	- (0%)	-	3.00 (1%)	100.00 (23%)	37.00 (9%)	288.00 (67%)	428.00 (100%)
	Apartment	1686.00 (92%)	-	68.00 (4%)	2.90 (<1%)	18.60 (1%)	61.70 (3%)	1837.20 (100%)
Office Building	Reinforced Concrete	1488.00 (88%)	-	73.00 (4%)	9.32 (1%)	13.91 (1%)	111.78 (7%)	1696.01 (100%)
	Steel	937.00 (83%)	-	55.00 (5%)	10.13 (1%)	17.82 (2%)	106.65 (9%)	1126.60 (100%)
	Steel Reinforced Concrete	1644.00 (86%)	-	122.00 (6%)	7.60 (<1%)	17.63 (1%)	125.86 (7%)	1917.09 (100%)
Public Building	Reinforce Concrete	1409.58 (88%)	-	67.01 (4%)	8.14 (1%)	12.15 (1%)	97.70 (6%)	1594.58 (100%)
	Steel	937.00 (84%)	-	55.00 (5%)	8.85 (1%)	15.57 (1%)	93.21 (8%)	1109.63 (100%)
	Steel Reinforced Concrete	1408.91 (85%)	-	122.00 (7%)	5.90 (<1%)	13.69 (1%)	97.70 (6%)	1648.20 (100%)

Conclusion

- Proposed unit generation rates are determined by reviewing and analyzing previous research data by using indirect method.

- Because all of references mentioning unit generation rates are fully reviewed, there is no need to practice additional research for determining unit generation rate by indirect method.

- Therefore, future research should focus on the direct method (actual measurement of C&D debris) according to the each building types.

- When estimating C&D debris amount at EIA project, this proposed unit generation rate can be used.