Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

March,2019

Promotion Council for Recycling Construction Materials and Wastes

Introductory notes on "Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN"

We act as the world top runner in terms of the policy system, actual recycling rate, and recycle technologies in the course of challenging to the Construction and Demolition waste (CDW) Recycling of Japan. (Refer to the description of following pages.)

The Promotion Council for Recycling Construction Materials and Wastes has pushed forward various activities, such as preparation of this "Case Studies", etc.

With these activities, the academic, business, and government will deliver jointly the information on advanced CDW recycling initiatives and technologies in Japan from Tokyo to all sections of Japan and further to the world.

Such activities were motivated by the opportunity of Japan attracting the world attentions because of The 2020 Tokyo Olympic and Paralympic Games

This "Case Studeis" has been compiled through cooperation of those concerned and will be reviewed as required from time to time.

Note that this "Case Studeis" is available in PDF form from the following address:
https://www.suishinkaigi.jp/en/works.html

March, 2019

Promotion Council for Recycling Construction Materials and Wastes

(Secretariat; Advanced Construction Technology Center (ACTEC))

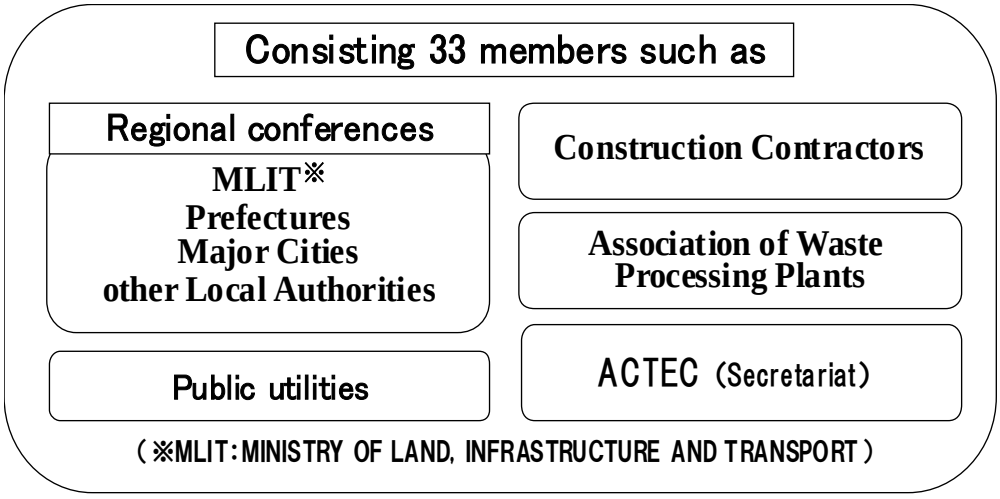
Construction and Demolition Waste(CDW) Recycling ratio of Japan and major EU countries

Country		Data annual	Amount of excavated soil generated (million tons)	CDW excluding excavated soil		Remarks
				Generation amount (million tons) *2	**Recycling ratio (%) *2**	
EU *1	Belgium	2012		14.8	**97.6**	
	Germany	2012	113.7	82.2	**96.0**	The recycling ratio not including backfill is 68%
	Netherlands	2012		24.2	**93.0**	
	United Kingdom	2012	54.4	44.8	**86.5**	
	Italy	2012		38.8	**76.0**	
	Spain	2012		27.6	**68.0**	
	France	2012		64.2	**63.0**	
Japan *3		FY 2012	180.1	66.1 (72.7)	**97.0 (96.0)**	Values in ( ) include construction sludge

*1: EU country data are organized by the Promotion Council for Recycling Construction Materials and Wastes secretariat (ACTEC) from the following HP country report
http://ec.europa.eu/environment/waste/studies/mixed_waste.htm

*2:excluding construction sludge
The recycling ratio of EU includes backfill.

*3: The data of Japan is MLIT "Survey Results of CDW 2012"

Promotion Council for Recycling Construction Materials and Wastes	
Secretariat	**Advanced Construction Technology Center (ACTEC)** Oak-Otowa Bldg., 2-15-6, Otsuka, Bunkyo-ku, Tokyo 112-0012, Japan Phone +81-3-3942-3991 Fax+81-3-3942-0424 URL:http://www.actec.or.jp/english/ E-mail:actecht@actec.or.jp
Founded	May 1992
HP URL	https://www.suishinkaigi.jp/en/index.html
Component Organizations	
Purpose	Our goal is to plan and effectively carry out activities to promote construction and demolition waste management, along with publicity to raise public awareness about promoting construction material and waste recycling (including "reduction," "reuse," "recycling" and "appropriate disposal"), in collaboration with our component organizations, to ensure the smooth implementation of construction work, effective use of resources, reduced generation of waste products and protection of our living environment.
Details of activities	**-O**rganization of the Technical Workshop and Exhibition on Construction and Demolition Waste Management (once per year) **-P**ublication of organization newsletter "Construction and Demolition Waste Management" (4 times per year) **-P**ublication of handbooks, pamphlets, books, etc. **-R**ecommendation of candidates for the 3Rs (Reduce, Reuse, and Recycle) Promotion Merit Awards **-P**rovision of various relevant information (news emails, website)

Listed on"Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN"

Measures Taken in Construction and Demolition Waste (CDW) Recycling in Japan

Environment and Recycle Planning office,
Policy Planning and Coordination Division for Public Works Project,
Policy Bureau, MLIT, Japan

MLIT
Ministry of Land, Infrastructure, Transport and Tourism

History of dealing with waste in japan

(Excretion treatment→Waste treatment→Sound Material-Cycle Society)

MLIT

Sanitary issues

Garbage and excretion were disposed of by ocean disposal and land disposal
Mosquitoes and fly arise from waste disposal sites
→Sanitary control required(since the 1945's)

Public Cleansing Act (1954)

Pollution issues

Increase in waste volume due to rapid economic growth
→Waste treatment by not only municipalities but also businesses is required.
Construction of incineration plants and landfill sites (since the 1955's)

Waste Disposal and Public Cleansing Act (1971)

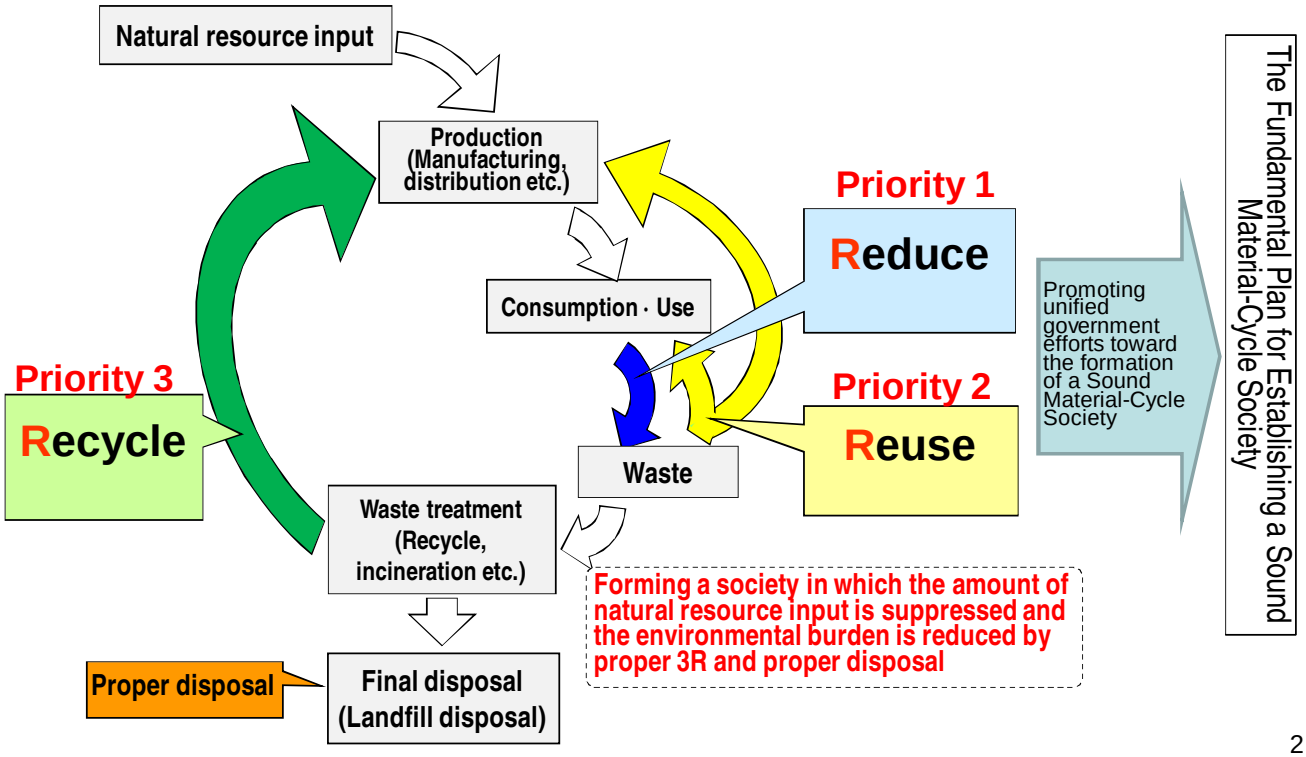
Environmental and resource issues

Proper treatment and utilization of waste,
More momentum on environmental issues
→Proper circulative resource such as recycling is necessary(since the 1989's)

Recycling law according to the individual waste (1995～),
Construction Materials Recycling Act (2000)
Basic Act on Establishing a Sound Material-Cycle Society(2001)

What is a Sound Material-Cycle Society ?

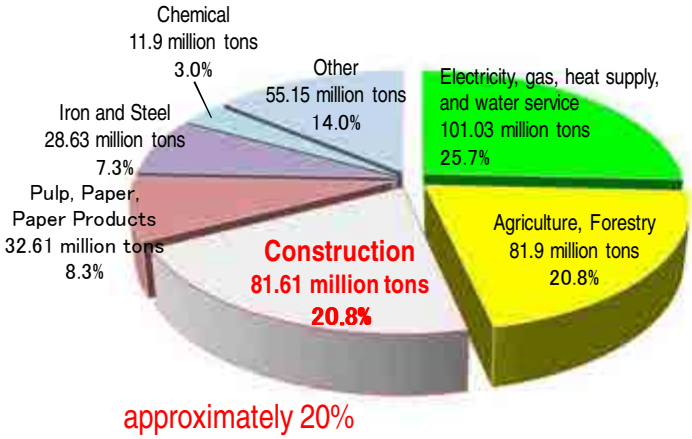
a "Sound Material-Cycle Society" means a society in which the consumption of natural resources will be conserved and the environmental load will be reduced to the greatest extent possible, by preventing or reducing the generation of wastes(Basic Act on Establishing a Sound Material-Cycle Society [promulgated in 2000, enforced in 2001] Article 2)



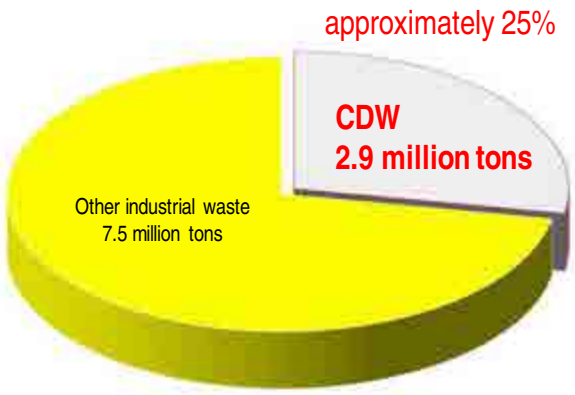
2

Generation and disposal of CDW

CDW accounts for approximately 20% of all industrial waste ,
and 25% of final disposed amount.



approximately 20%



Total 392.84 million tons → 2.6% → Total 10.4 million tons

Generated amount

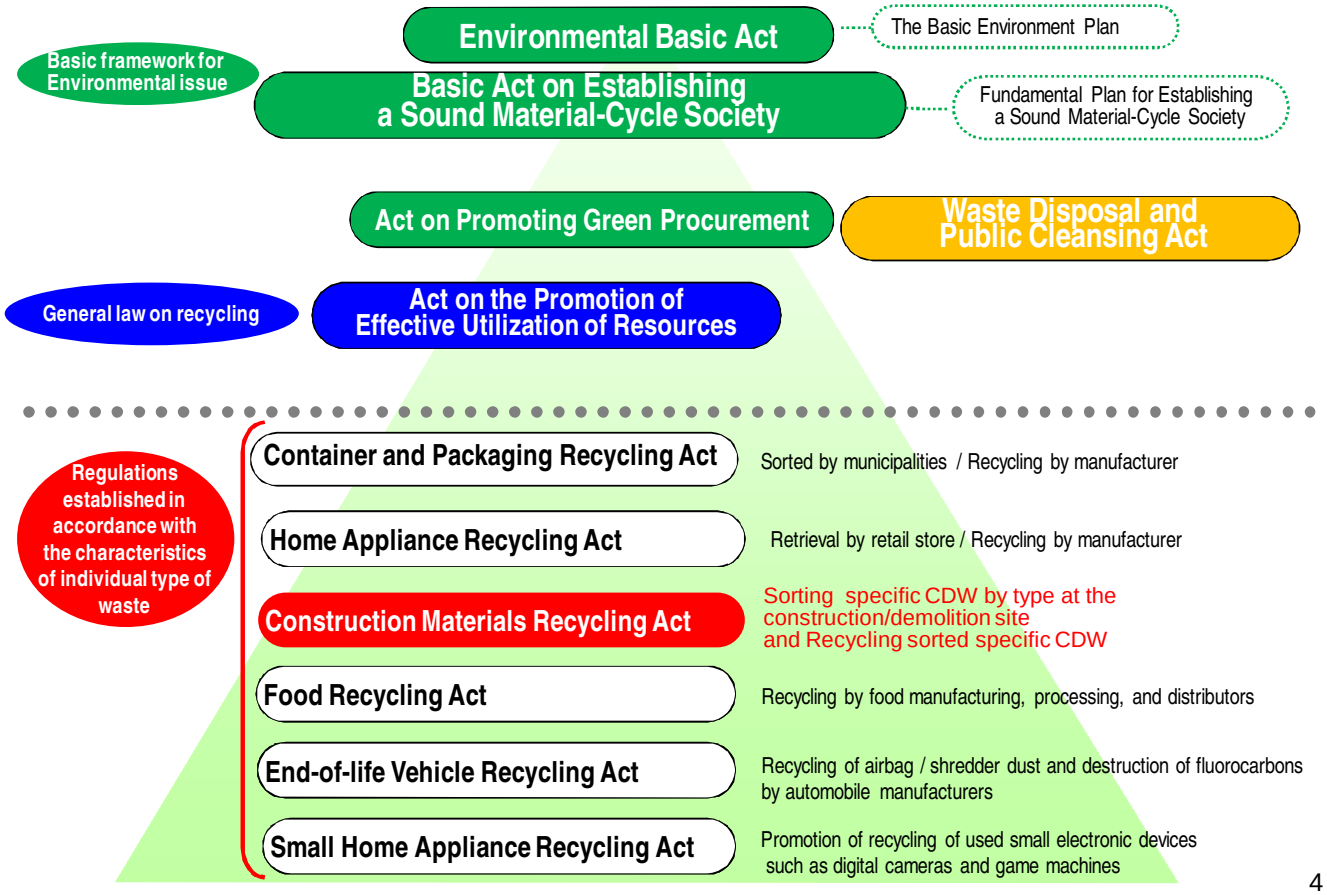
(result in fiscal year 2014; Ministry of Environment)

Final disposed amount

※Other industrial waste; result in fiscal year 2014; Ministry of Environment
※CDW; result in fiscal year 2012; MLIT

3

System of legislation designed to establish a sound material-cycling society



Construction Material Recycling Act

Under the Construction Material Recycling Act, construction contractors of a certain scale or more were required to sort and recycle specific CDW.

(Established in 2000, enforced in 2002)

Applicable construction works

- demolition work of building : total floor space ≧ 80㎡
- construction work or enlargement work : total floor space ≧ 500㎡
- civil engineering work : contract fee ≧ 5 million yen
- repair work or remodeling : contract fee ≧ 100 million yen

Specific construction materials

concrete, construction material from concrete and iron, wood asphalt concrete

Obligation to implement construction contractor

Sorting CDW

Sorting specific CDW by type at the construction /demolition site.

※specific CDW is CDW of specific construction materials

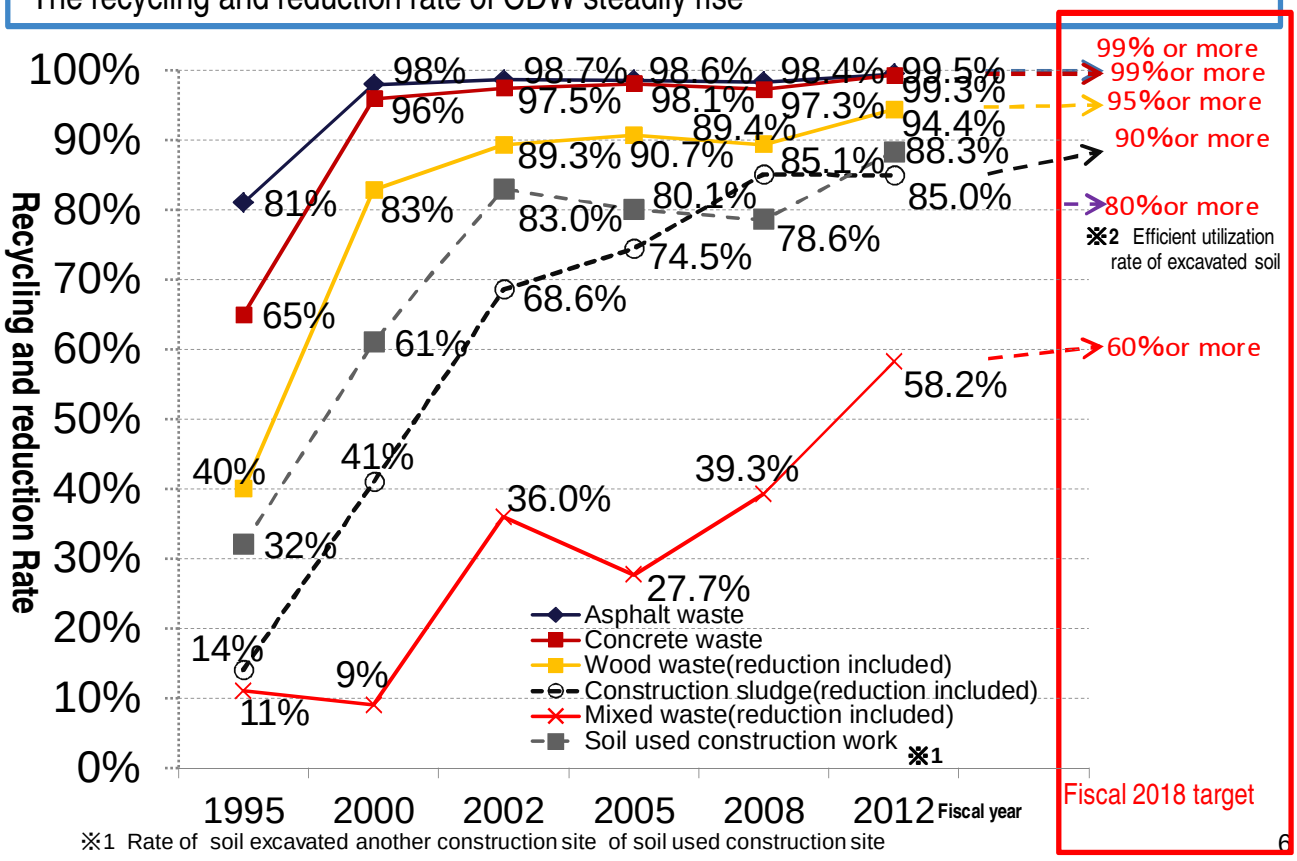
Recycling CDW

Recycling sorted specific CDW

※ Recycling is the act of putting it in a state that it can be used as a material or raw material or making it available for obtaining heat energy by combustion

Recycling and reduction Rate of CDW

The recycling and reduction rate of CDW steadily rise



※1 Rate of soil excavated another construction site of soil used construction site

6

Outline of "Construction Recycling Promotion Plan 2014"

7 main themes

(1) Set up ways to monitor CDW .
(2) Resolve regional problems.
(3) Work in coordination with other environmental policies.
(4) Be sure to make reducing plans at the design stage.
(5) Be sure to sort waste at construction sites and to carry waste to proper plants.
(6) Make use of CDM.
(7) Make a proper system for recycling construction soil(excavated soil).

10 sub themes

(1)Information management and logistics management ,(2) Strengthen cooperation among related parties,(3) Promotion of understanding and participation,(4) Fostering CDW recycling market,(5) Promotion of technology development etc.(6)Prevention,(7)On-site sorting,(8)Recycling and reduction ,(9)Appropriate disposal ,(10)Reuse/Use of recycled materials

7

New themes for the next generation of Construction Recycling Plan

MLIT

1. Supply system innovation and Work-style reform

- AI ⇒ Recycling facilities etc.
- BIG DATA ⇒ "COBRIS(Construction Byproducts Resource Information Interchange System) "
  "e-Manifests"
- DRONE ⇒ Demolition site patrols in order to ensure the enforcement of Construction Materials Recycling Act etc.

2. Maintenance and renovation era

- How will it change from now?
- What kind, quantity and quality of CDW generated in large quantities?

3. "The Basic Rule on CDW "

- By the rule ,can't carry excavated soil over 50 km from an original site to another.

4.Promoting use of recycled materials

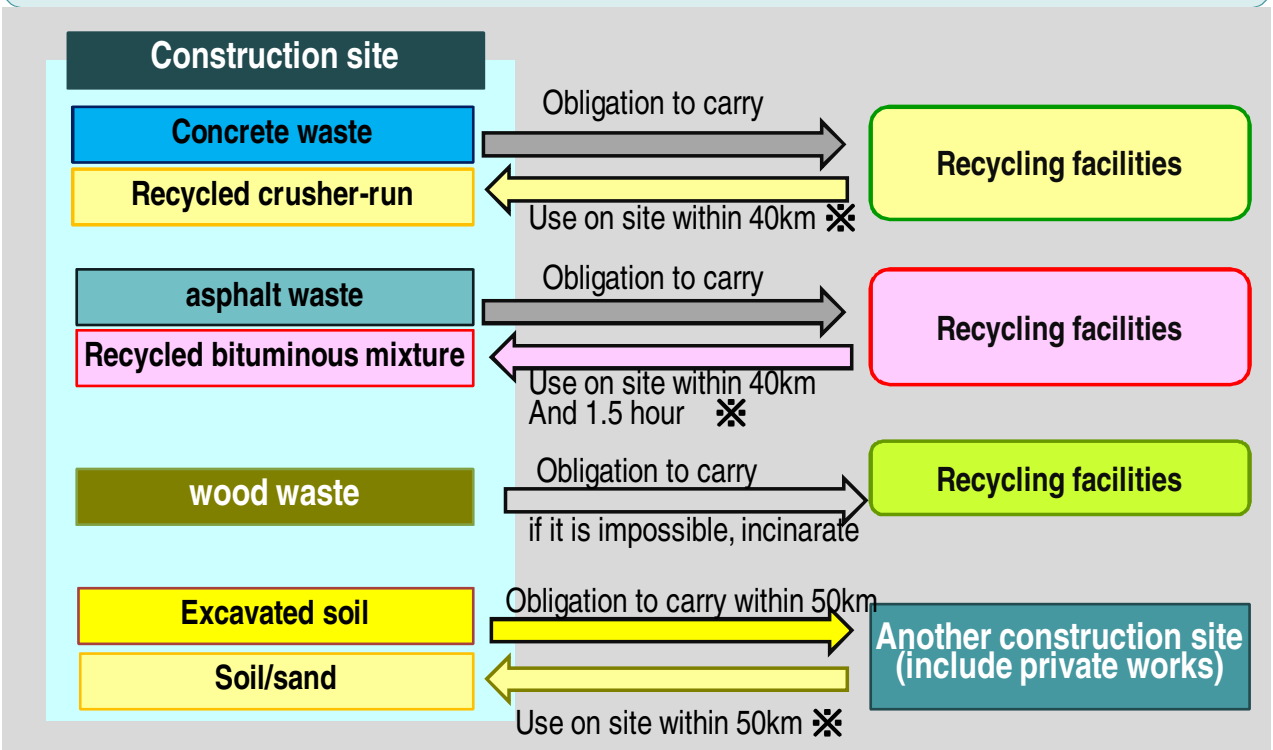
- Recycling rate of concrete waste is already up to 99%.

⇒ Another index for recycled concrete waste.

"The Basic Rule on CDW "

MLIT

Regardless of any economic reason, you must keep this Basic rule of CDW recycle in Public Works.

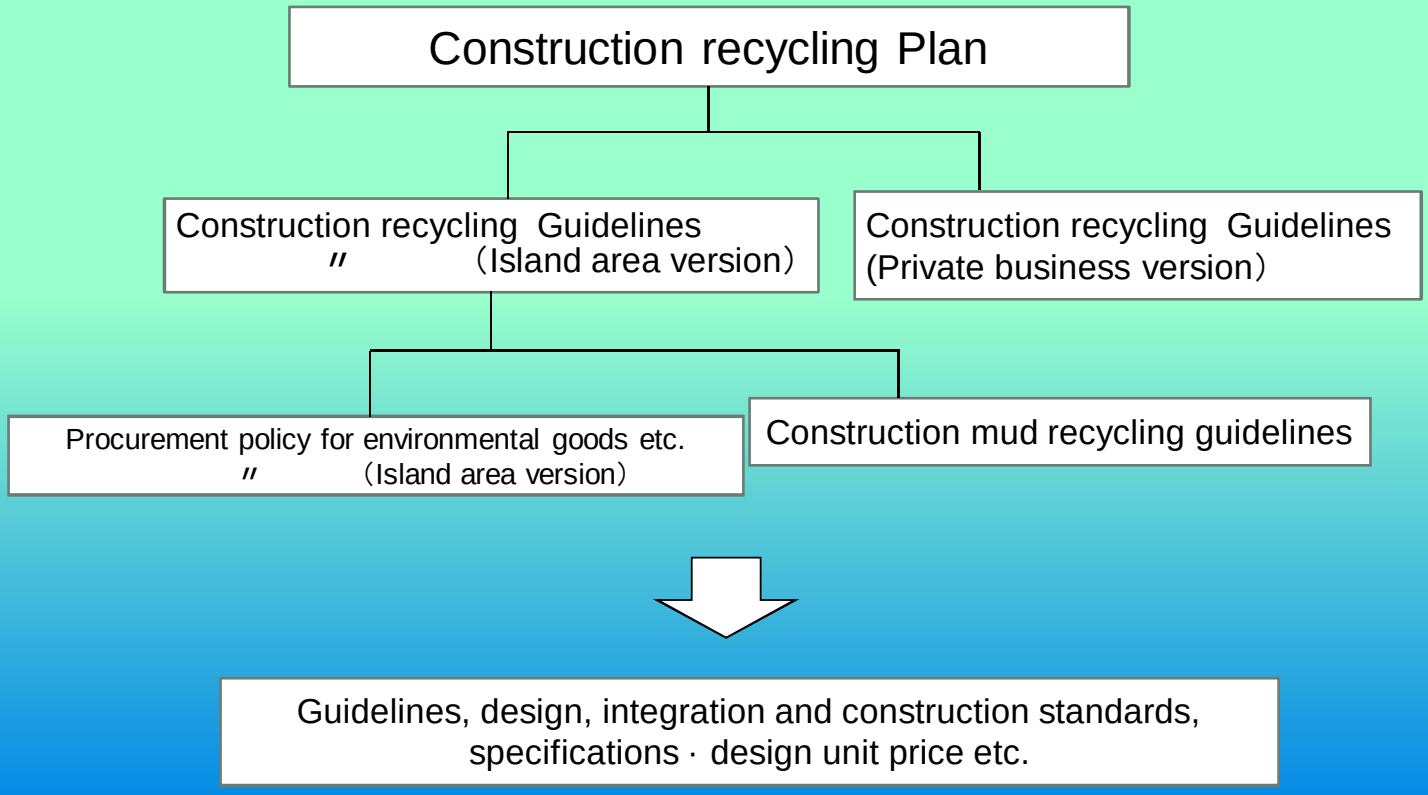


※Use it on condition that the required quality is satisfied

Measures Taken in Construction and Demolition Waste (CDW) Recycling In Tokyo Metropolitan Government

Regional Coordination Section
Urban Development Policy Division
Bureau of Urban Development
Tokyo Metropolitan Government

【System of construction recycling promotion plan etc. of Tokyo Metropolitan Government】



Tokyo Metropolitan Government Construction recycling Plan

Establish nine strategies focused on ensuring the effectiveness of construction resource circulation

Strategy 1 Utilize concrete waste and other

Strategy 2 Utilize woods waste

Strategy 3 Utilize construction mud

Strategy 4 Utilize construction soil(excavated soil)

Strategy 5 Utilize waste for construction materials

Strategy 6 Carry out green procurement in construction work

Strategy 7 Long-term use of buildings etc.

Strategy 8 Build a foundation to support the strategy

Strategy 9 Promote construction recycling in the island area

Tokyo Metropolitan Government Construction recycling Guideline

Purpose

- In order to steadily promote the strategy of promotion plan, we set necessary matters concerning the implementation of various measures concerning construction resource recycling

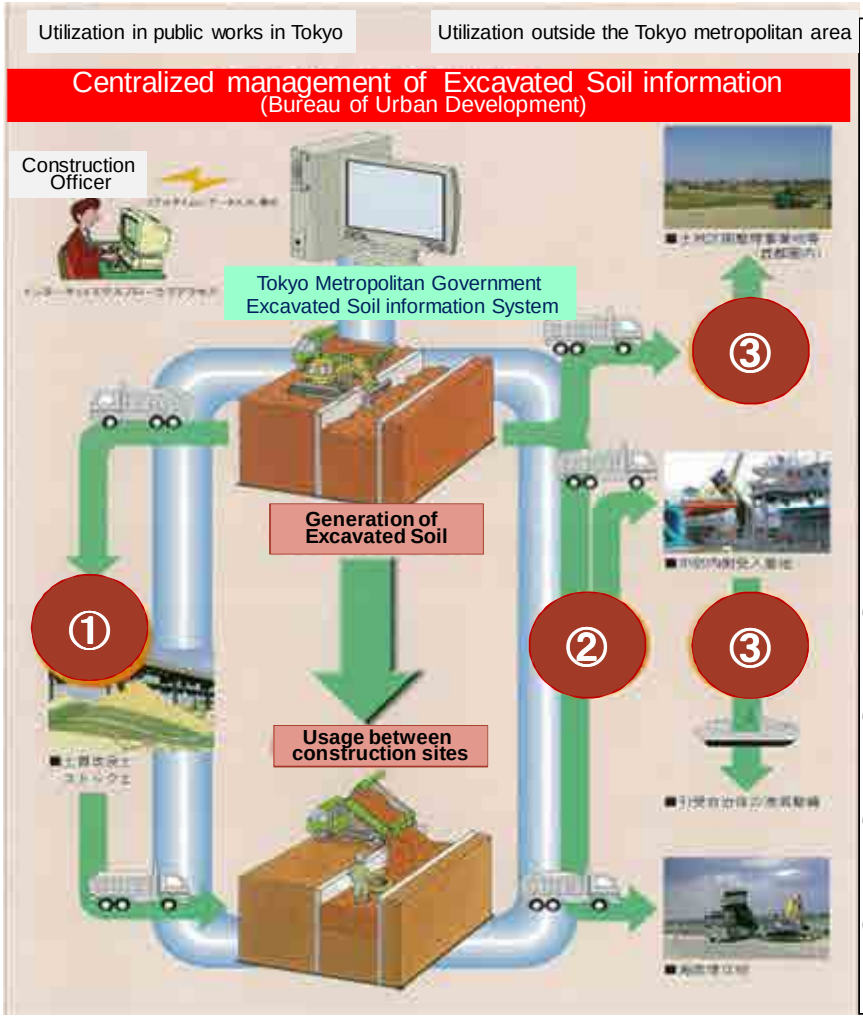
Scope of application

- Tokyo Metropolitan governments, supervision organizations, reporting organizations and wards, municipal orders, private works

Point

- Creation of Recycling Plan
- Recycling of construction and Demolition Waste
- (excavated soil, concrete waste, etc.)
- Green procurement in construction work

Reuse Flow of Excavated Soil



≪Forecast of the amount of soil generated≫

・Input of the next year quantity in the second half of the previous fiscal year, adjustment of the organization utilizing soil generated

≪Usage between construction sites≫

・Search for construction works that can be used between constructions using information system based on registration information

≪Adjustment for designated utilization organization of Excavated soil≫

・Adjust the registered data with the organization utilizing soil generated, determine the availability

【Designated utilization organization of Excavated soil 】

①Tokyo Metropolitan Construction Waste Soil (Excavated Soil) Recycling Center
(Ariake district, Oume district, Akishima district)

②Tokyo Harbor Pier Co., Ltd.
(New ocean Disposal Site)
(Disposal site inside the central breakwater)

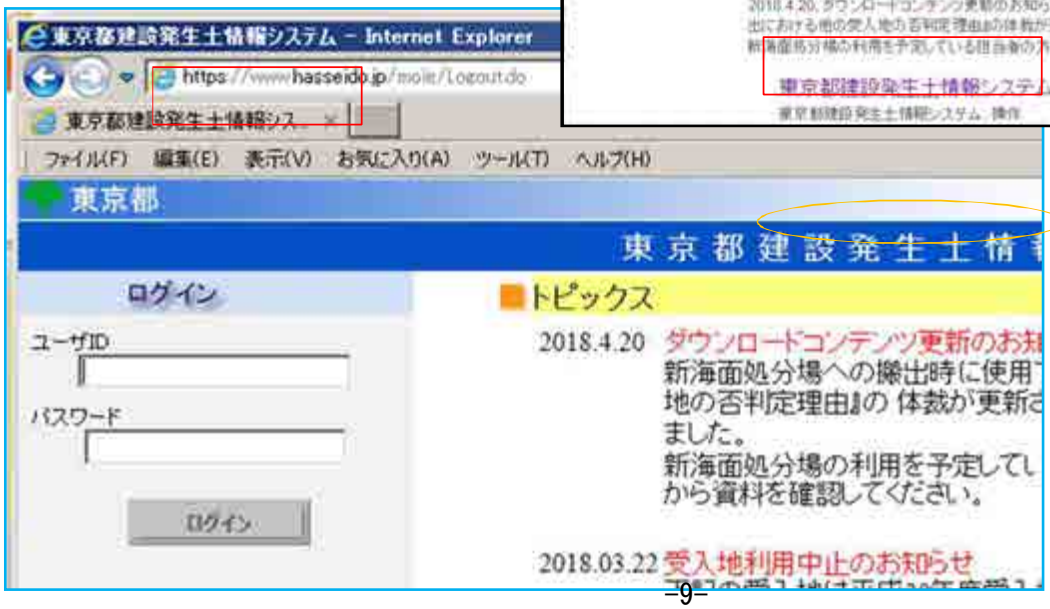
③Utilization of Construction Resource Center Co., Ltd **(UCR)**
(23 Used site of Excavated Soil)

④Excavated Soil improvement plant located at Nakagawa district
(Only for Sewerage Bureau)

Tokyo Metropolitan Government Excavated Soil information System

https://www.hasseidojp/

（Only Japanese ）



Recycling recycled aggregate made from concrete waste

Use as recycled crusher-run

It is important to expand the application of recycled crusher-run

Concrete waste

Construction site

Building Demolition work

Concrete waste must be recycled

Article18 of the Construction Materia(l Recycling Act)

90% or more

再資源化施設へ搬入・破砕して再資源化

Recycling facility (crushing facility)

Use in road construction

Use outside road construction

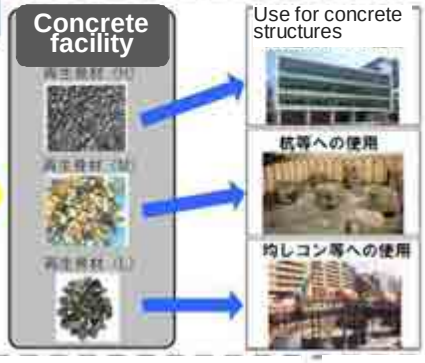
Use as concrete aggregate

再生骨材プラントへ搬入

Recycled aggregate facility

Recycled aggregate H,M,L

Concrete facility



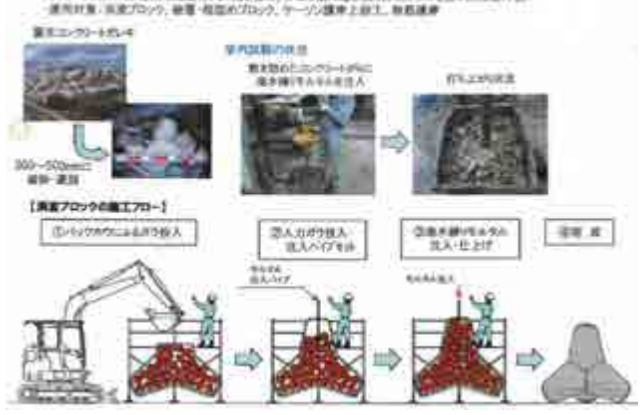
It is important to improve the ratio of extracting aggregate from concrete waste

Cases using recycled aggregate concrete

River construction work

Building construction work

Port construction work



Trend of Recycled Aggregate Concrete

Recent situation of related standards

- March, 28,2016 Ministry of Land, Infrastructure and Transport(MLIT)
  "Quality standards by application for recycling of concrete waste"
  > Recycled aggregate concrete M can be used as a structure of muscle concrete.
- Jun,2016 Ministry of Land, Infrastructure and Transport(MLIT)
  "Revised Building Standards Law Notice"
  > The JIS standard conforming to Building Standards Law was changed from 2003 version to 2014 version.
  > It became unnecessary to acquire certification by the minister when using ready mixed concrete using recycled aggregate H as a structural material.

JIS Standard

- JIS A 5021(March,2005):recycled aggregate H for concrete
- JIS A 5022(March,2006):recycled aggregate M for concrete
- JIS A 5023(March,2007):recycled aggregate L for concrete

Tokyo Metropolitan Government

- Certification system for quality standards of recycled crusher-run(Fiscal Year 2017)
  > Tokyo Metropolitan Government (Environment Bureau) certifies the quality criteria of recycled crushed-run determined by private organizations.
  > We also certify manufacturing facilities that meet the certification criteria.
- Usage of recycled crusher-run
  > We are promoting the use of recycled crusher-run as roadbed material, infiltration trench material, gravel compaction material, backing material for retaining walls.

JIS overview of recycled aggregate for concrete

		Recycled aggregate for concrete-Class H	Recycled aggregate concrete-Class M	Recycled aggregate concrete-Class L
Water absorption of aggregate	Coarse	3% or less	5% or less	7% or less
	Fine	3.6% or less	7% or less	13% or less
Main applications		There is no particular limitation, general purpose concrete	Concrete for piles, foundation beams, steel pip filling	Concrete not requiring high strength and durability such as leveling concrete
JIS Standard		**JIS A 5021:2018** Recycled aggregate for concrete-Class H	**JIS A 5022:2018** Recycled aggregate concrete-Class M	**JIS A 5023:2018** Recycled aggregate concrete-Class L
	Established date of standard	**March 20,2005**	**March 20,2007**	**March 20,2006**
Purpose of JIS standard		Standard for recycled aggregate used for concrete for general use which improved quality as aggregate by advanced treatment such as crushing and abrasion of concrete waste	Standard for recycled aggregate produced by a comparatively simple method such as crushing and abrasion of concrete waste for concrete which is hardly affected by drying shrinkage and freezing and thawing	Standard for recycled aggregate of relatively low strength concrete using recycled aggregate produced by crushing concrete waste

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

Affiliation	Affairs Council of Recycled-Aggregate Concrete(ACRAC)	
Location	201B,4-1-1 Nishi Azabu Minato-ku, Tokyo 106-0031	
Position:	ACRAC Executive Director	
Name/Surname	EIGO　IDE	
e-mail	info@acrac.org	
Title	**ACRAC Quality audit system (Quality audit system on recycled aggregate for concrete)**	
Theme classification		Prevention
		Re-use
	○	Recycle
		Reduce Co2
		Legacy
		Business to overseas
		Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020
Specific content	This audit system for ACRAC members is a system to objectively audit the quality of recycled aggregate for concrete from 2013. The "Recycled Aggregate Concrete Committee" to conduct the final judgment consists of six members, chaired by academics and experts (civil engineering and construction), administrative officials, research institutions, users, related people and five members of the ACRAC Quality Audit Committee. At ACRAC, due to the audit by the Audit Committee and the approval of the Recycled Aggregate Concrete Committee, we have issued an approval letter for the use of the appropriate mark to manufacturing plants that conform to the quality audit system. At ACRAC, nine manufacturing plants nationwide are currently certified as conforming factories. appropriate mark	
Appeal point	As the quality audit system on recycled aggregate for concrete using concrete waste as the raw material, it is the first in Japan.	

Affairs Council of Recycled-Aggregate Concrete (ACRAC)

Quality audit system

(Quality audit system on recycled aggregate for concrete)

1. Outline of the quality audit system

- Targets are ACRAC member companies.
- The auditors designated by the "Quality Audit Committee" comprising representatives of ACRAC member companies.

  (The chairman selects the auditors from the concrete engineers, chief engineers, and those with equivalent or higher qualification.)

  → Audit to be executed by a pair of two auditors
- Quality audit is to be executed according to the ACRAC Quality Audit Standard.

The audit results are summarized in the "Quality Audit Report" and determined to be acceptable if justified by discussions in the "Quality Audit Committee" that comprises the people of experience or academic understanding, persons concerned with administration, persons concerned with users, and the chairman and members selected by the ACRAC working group.

2. Quality Audit Standard

The quality audit standard is classified into “General Requirements,” “Particular Requirements,” “Field Inspection (Product Sampling Inspection).”

Classification	Items	Contents
A. General requirements		(1) Quality assurance
		(2) Compliance of eco-friendly goods and services procurement
		(3) Reduction of environmental impact
		(4) Securing of technical capacity
		(5) Training
		(6) Handling of non-compliance
		(7) Environmental protection
B. Particular requirements	1.Product management standard	(1) Clarification of product quality
	2. Manufacturing management standard	(1) Original concrete (2) Manufacturing method (3) Manufacturing process quality
	3. Equipment management standard	(1) Manufacturing equipment management (2) Inspection equipment management
	4. Outsourcing management standard	(1) Outsourcing management
C. Field inspection	Product inspection	(1) Density (2) Percentage of absorption (3) Content of materials finer than 75μm sieve

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

Affiliation	Kinki Regional Construction & Demolition Waste measure liaison council(Secretariat; MLIT Kinki Regional Development Bureau)	
Location	1-5-44 ootemae chuuou-ku, OOSAKA, JAPAN 540-8586	
Position:	Technical Research section , Planning Division	
Name/Surname		
e-mail		
Title	**“Kinki Construction Recycling Award”** **(Award system for CDW recycling promotion activities in Kinki region)**	
Theme classification		Prevention
		Re-use
		Recycle
		Reduce Co2;
		Legacy
		Business to overseas
	○	Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020

Specific content

< Organizer>
- Kinki Regional Construction & Demolition Waste measure liaison council(Secretariat; MLIT Kinki Regional Development Bureau)

< Established Date>
-FY 2010

< Purpose>
- By honoring to promote construction & Demolition Waste(CDW) recycling, we will enrich 3R (Reduce, Reuse, Recycle) initiatives and expand the circle of action towards the establishment of a " Sound Material-Cycle Society " in which recyclable resources are appropriately and effectively used and disposed.

< Object>
- Individuals, organizations, or business operators who are voluntarily and proactively promoting CDW recycling in the Kinki region

< Type / Category>
- Selected "Chairperson's Award" and "Encouragement Award" for each of three categories, "Reduction / Restraint of Emission", "Reuse / Recycle Department" and "Recycling Department"

< Review method>
- “CDW Recycling Award Review Committee" established at the Kinki Regional Construction & Demolition Waste measure liaison council judged based on the "examination criteria"

< Awards record: number>

FY	Chairperson's Award	Encouragement Award	Total
2010	2	5	7
2011	3	6	9
2012	3	4	7
2013	4	3	7
2014	3	6	9
2015	2	2	4
2016	3	5	8
2017	3	6	9

Appeal point

- Award system limited to CDW recycling(The only award system in Japan)

- "R & D, educational awareness activities, etc." are also awarded in addition to practical work related to CDW recycling (construction, CDW treatment, etc.)

-The winners have points of addition (1 points of chairman's award, 0.5 points of encouragement award) in the comprehensive evaluation bidding method for the order construction works of the Kinki Regional Bureau.

“Kinki Construction Recycling Award”

(Award system for CDW recycling promotion activities in Kinki region)

< Type / Category>

The winners are selected by the judging committee for each of the following awards categories among the candidates recommended by the recommendation organization※

※Constituent body of the Kinki Regional Construction & Demolition Waste(CDW) measure liaison council。
Prefectural Industrial Waste Association
Prefectural Demolition Business Association
Architectural Institute of Japan Kinki branch

(1) Chairperson's Award
(2) Encouragement Award(The object of the award is as follows)

Department name	Target activity etc.
Waste Prevention	(General) -Efforts to waste prevention and enlightenment activities -R & D and Educational ,enlightenment activities on waste prevention
	(Construction work) -Efforts to waste prevention and enlightenment activities at construction sites -Efforts to site separation and enlightenment activities at demolition construction site
Reuse/Usage of recycled construction materials	General) - Efforts to Reuse/Usage of recycled construction materials and enlightenment activities - R & D and Educational ,enlightenment activities on Reuse/Usage of recycled construction materials and enlightenment activities
	(Construction work) - Efforts to Reuse/Usage of recycled construction materials and enlightenment activities at construction site
Recycling	- Recycling of CDW at recycling facilities - R & D and Educational ,enlightenment activities on CDW Recycling

< Examination criteria>

The organizer will evaluate the following items for individuals, organizations, business operators, etc. who have made remarkable CDW recycling promotion achievements in activities

Evaluation items		Specific evaluation items
Improve recycling rate / Waste Prevention	Duration of activity	Evaluate the continuity of the same initiative
	Effect of activity	Evaluate the recycling rate and effect (waste prevention, resource saving, energy conservation, environmental conservation)
Improve the quality of recycling	Regionality	Evaluate activities based on the characteristics of the Kinki region
	Frequency	Evaluate the frequency of activities
	Originality / Initiative	Evaluate the originality of activities (Including technology development)
	Effect of activities spread	Evaluate the effect of other companies' activities
	Others	Evaluate the characteristics of active organizations etc.

※Examples of activities not to be evaluated

- Activities by technology already popularized in the Kinki region and adopted as a standard construction method
- Activities relating to environmental and quality control standards (,ISO,eco-action21 etc.) which are already popular
- Activities not contributing to 3R
- Activities that can not confirm the effect of activities by numerical values or materials

If the following facts are found after the award, the organizer shall be able to cancel the award

-In cases where the activity causes socially significant damage due to illegal acts etc.

-In cases where the activity falls into a matter that does not significantly match the purpose of this award system

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

<table>
<tr><td>Affiliation</td><td colspan="2">RYOMA KITAGAKI,
The Associated General Contractors of Tokyo
Association of Building Demolition Contractors of Tokyo
Tokyo Industrial Waste Association</td></tr>
<tr><td>Location</td><td colspan="2">Kita 10, Nishi 8, Kita-ku, Sapporo 060-0810, JAPAN</td></tr>
<tr><td>Position:</td><td colspan="2">Associate Professor,
Faculty of Engineering, Division of Human Environmental Systems, Building Engineering Laboratory, Hokkaido University (RYOMA KITAGAKI)</td></tr>
<tr><td>Name/Surname</td><td colspan="2">RYOMA KITAGAKI</td></tr>
<tr><td>e-mail</td><td colspan="2">ryoma@eng.hokudai.ac.jp</td></tr>
<tr><td>Title</td><td colspan="2">New quality management codes for low quality recycled aggregate named "Tokyo brand ‘Cool eco-Stone’", extending applicability for several soil/ground materials.</td></tr>
<tr><td rowspan="7">Theme classification</td><td></td><td>Prevention</td></tr>
<tr><td></td><td>Re-use</td></tr>
<tr><td>○</td><td>Recycle</td></tr>
<tr><td></td><td>Reduce Co2</td></tr>
<tr><td></td><td>Legacy</td></tr>
<tr><td></td><td>Business to overseas</td></tr>
<tr><td></td><td>Etc.</td></tr>
<tr><td rowspan="3">Technology development stage</td><td>○</td><td>Practical use</td></tr>
<tr><td></td><td>Scheduled to be put into practical use by 2020</td></tr>
<tr><td></td><td>Scheduled to be put into practical use after 2020</td></tr>
<tr><td>Specific content</td><td colspan="2">-This code is a quality standard of recycled aggregate established by the cooperative committee among industries, local governments and academia for branding recycled aggregates which have much attached mortar.
This quality standard aims to be widely used not only for roadbed materials but also general geomaterials(ground materials).
.
-The characteristics of this code is to design the grades of concrete wastes for applying embarkment, pervious foundations, and drainage systems as well as conventional road base/subbase. As a result, the quality of concrete wastes become improved and connect into manufacturing high quality recycled materials applied to several soil structure.</td></tr>
<tr><td>Appeal point</td><td colspan="2">-this quality standard designed comprehensively for recycled geomaterials(ground materials) made from concrete waste is unprecedented worldwide.

-Tokyo Metropolitan Government has also publicly certified this private quality standard, and its recognition as a brand is increasing.

-Through creating a quality standard for recycled materials and establishing the goal of setting up as a brand, we are proud that many people have involved to improve the image of recycled materials and the comprehensive framework has been created to contribute to promoting recycling.</td></tr>
</table>

New quality management codes for low quality recycled aggregate named "Tokyo brand ‘Cool eco-Stone’", extending applicability for several soil/ground materials.

1. Quality Management process for low quality recycled aggregate extending applicability to several soil/ground materials.

Tokyo brand “Cool eco-Stone”, new codes for low quality recycled aggregate is assumed to be designed for extending applicability to several types of geomaterials as well as recycled crusher-run for road base/subbase. Specifically, Tokyo brand “Cool eco-stone” is considered to satisfy the following two requirements:

① Sufficient mechanical performances required for geomaterial, such as embarkment, pervious foundations, and drainage systems

② Extreme low concentration of any harmful components such as chromium hexavalent, which may cause critical adverse environmental changes in the ground.

In order to satisfy these requirements of “Tokyo brand ‘Cool eco-stone’”, the special committee consisting of all stakeholders, such as related industries, local governments and academia, established the codes for quality management system in close cooperation.

According to these codes, the comprehensive quality management system covering from concrete wastes generated in demolition sites to recycled aggregate applied in construction sites are standardized accurately. These codes include the rating system of quality of concrete wastes qualifying into A, B, and C. In consequence, the rating system succeeds the improvement of the quality of recycle aggregate, because the cost for controlling quality of recycled aggregates would be decreased and the quality consistency in manufacturing recycled aggregate would be improved with low cost. It is a simple but an innovative system to progress recycling concrete wastes.

2. Performance of recycled aggregate applying as ground materials

Table 1 shows the standard (draft) for recycled aggregate named Tokyo brand “Cool eco-stone”.
This standard (draft) requires that recycled aggregate applying in ground proves environmental safety in compliance with the standard value of “Soil Contamination Countermeasures Act” based on the result of leaching test (JIS K 0058-1) in the “as-is” use form and the results of contents test (JIS K 00580-2) , so as that surrounding soil and groundwater might sustain environmental safety for a long time.

Additionally, the codes require to disclose several values for contributing to awareness of the quality and recasting public images of recycled aggregates.

Table-1 standards (draft) of recycled aggregate for applying as geomaterials

Items for quality management		Standards of test methods for each item	Names of recycled aggregates	Conventional recycled crusher-run	RC-40 For roadbed	RS-40 For infiltration trench	RC-40 For gravel compaction	RC-40 For back-filling
			Construction method applying each product	Roadbed construction	Roadbed construction	Permeability method	Foundation improvement work	Earthwork
			Function of recycled aggregate	Roadbed material	Roadbed material	Infiltration trench material	Gravel compaction	Backfilling material
Regulations on harmful component content	Heavy metal elution/ content	JIS0058-1 or JIS0058-2		—	Based on the following two test results 1. To satisfy the dissolution amount criteria (Type 2 Specified Hazardous Substance) of Soil Contamination Countermeasures Act by dissolution test(JISK0058-1) on appearance sample 2. To satisfy the content criteria (Type 2 Specified Hazardous Substance) of Soil Contamination Countermeasures Act in content test(JISK0058-2) of crushed sample			
	Chloride content	JISA5023A4.7		—	0.04wt%			
	Ph	JGS0211		—	Disclose data			
	Electrical conductivity	JGS0212		—	200mS/m or less			
	Ignition loss	JISA1226		—	10% or less			
	Asbestos content	JISA1481-1		—	Do not detect			
	Impurity contamination rate	JISA5023A4.2		To satisfy the civil engineering material specification (edited by Construction Bureau ,Tokyo Metropolitan Government)				
Regulations on physical mechanics characteristics	Grain size distribution	JISA1102		—	To satisfy the civil engineering material specification (edited by Construction Bureau ,Tokyo Metropolitan Government)			
	Solid volume percentage	JISA1104		—	Disclose data	65%or less	Disclose data	
	Fine fraction content	JISA1223 or JISA1103		—	less than 10%	2% or less	less than 10%	
	Water absorption	JISA1110		—	8.65% or less	7% or less	9.1% or less	8.65% or less
	Density in absolutely dry condition	JISA1110		—	2.05g/cm3 or more	2.1g/cm3 or more	2.03g/cm3 or more	2.05g/cm3 Or more
	Density in saturated surface-dry condition	JISA1110		—	Disclose data			
	Mass of unit volume	JISA1104		—	Disclose data			
	Percentage of wear	JISA1121		40% or less				
	Plasticity index	JISA1205		6% or less		-	6% or less	
	Plastic limit	JISA1205		—	Disclose data	—	Disclose data	
	Liquid limit	JISA1205		—	Disclose data	—	Disclose data	
	Cone index	JISA1228		—		—	400KN/m3 or more	
	Maximum dry density	JISA1210		—	Disclose data			
	Optimum moisture content	JISA1210		—	Disclose data			
	Modified CBR	JISA1211		40% or more		Disclose data	40% or more	
	Expansion ratio	JISA1211		—	3% or less			
	Method of classification of Geomaterials for engineering	JGS0051		—	Disclose data			
	Internal friction angle	JGS0524		—	Disclose data	35degree or more		
	Cohesion	JGS0524		—	Disclose data			
	Slaking rate	NEXCO testing method110		—	Disclose data	1% or less		
	Hydraulic conductivity	JISA1218		—	Disclose data	$1x10^{-4}$ m/sec		

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

Affiliation	HAZAMA ANDO CORPORATION
Location	6-1-20, Akasaka, Minato-ku, Tokyo 107-8658, Japan
Position:	Manager, Technical Planning Department, Technical Division
Name/Surname	HIROYUKI AKITA
e-mail	akita.hiroyuki@ad-hzm.co.jp

Title	**Effective utilization technology of fly ash and coal ash**	
Theme classification		Prevention
		Re-use
	○	Recycle
		Reduce Co2
		Legacy
		Business to overseas
		Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020

Specific content

(1) Technology to harden coal ash

As a technology that can effectively utilize coal ash powder discharged from a coal-fired power plant in large quantities, we developed an "ash- crete" having a formulation that minimizes unit water content without using aggregate.

The points of "ash- crete"technology are as follows

①Efficiently express strength by compounding design with optimal water content ratio as an indicator

②"ash- crete" is manufactured using "superfluid construction method" developed by our company. The"superfluid construction method" is a unique construction method which compacts and mixes powder mixed with very little amount of water by strong vibration

③For coal ash with large quality fluctuation, it is possible to quickly select blending by simple flow test.

(2) Type of "ash- crete"

①"ash- crete"

For manufacturing block of artificial seabed mountains

②"ash- crete" TypeⅡ (AC-Ⅱ)

For embankment / roadbed material of residential land construction work, coast maintenance work etc.

③"ash- crete" TypeS (AC-S)

For general embankment materials

Appeal point

- we have made effective use of over 1 million tons of coal ash, due to the development of "ash- crete" technology using coal ash powder. We will continue to actively make effective use of fly ash and coal ash and contribute to the reduction of co-fired by-products.

Effective utilization technology of fly ash and coal ash "ash- crete" TypeS（AC-S）

High-quality safe hardened body, "Ash-crete," whose chief material is large amount of coal ash, "fly ash," generated from coal-fired power plants, is applicable to most of marine block structures, such as artificial submarine mountains, seaweed bed blocks, artificial fish rests, etc.

Ash-crete Type S is a product for construction of embankment, which has been produced by utilizing the manufacturing technology of this hardened body. Its versatility has been enhanced through crushing to enable its handling in a manner similar to the case of ordinary embankment materials.

"S" of AC-S stands for the followings:

Shinchi (town),
Soma (City), and
Safety.


【AC-S】

Namely, this "S" indicates the key factor of development, that is, contribution through local consumption of locally produced coal ashes from the Shinchi Power Plant of Soma Kyodo Power Company, and the wish for early reconstruction of quake-damaged areas.

【Usage and features of AC-S 】

Usage ; Embankment, Underground Roadbed
Weight ; 20% lighter than general embankments
Safety ; Clear soil environmental standard
Strength ; Compressive strength 10 to 15N/mm2
grain size ; 200 mm or less, Adjustable


【混練プラント】

【Manufacturing process】

Production of cured body　Primary crushing　Secondary crushing　Product shipment

【Construction example】

AC-S has been employed for rehabilitation of the prefectural road, Soma Watari Route. With the supply started in July 2015, about 36,000 m^3 of AC-S supply is scheduled by March 2016.

Coal ashes, the effective resources of the location of the coal-fired power plant, will be further recycled in the future in the form of AC-S, thereby preventing nature destruction due to quarrying of natural embankment materials and contributing to the surrounding regions.

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

Affiliation	KAMEI SEITO Co.Ltd.	
Location	1258 Kasahara-cho Tajimi-shi Gifu, Japan	
Position:	President	
Name/Surname	Hiroaki Kamei	
e-mail	h-kamei@eco-angels.com	
Title	**Non-fired eco bricks**	
Theme classification		Prevention
		Re-use
	○	Recycle
		Reduce Co2
		Legacy
		Business to overseas
		Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020
Specific content	- Non-fired eco bricks are utilized, Sewer sludge, burned ash, coal ash, ceramics abolishedsoil [Kira], molten slag, glass waste and many otherunused resources and are regenerated to form a revolutionary brick style block, without baking, using our special slodificaton technology (Patentprocess).	
Appeal point	- Non-fired eco bricks has a texture of pottery and abundant color, yet it is non-baked, realizing low price and good workability. - In addition, it meets strict criteria for safety such as strength slip resistance, elution of harmful substances and can be used with confidence. - A newly developed Eco brick, friendly to the earth, which does not burn fossil fuels that cause global warming at least 80% of the recycled material ratio, Non-fired eco bricks is a product born of the demands of the era.	

We develop eco products
for global environment.

We reuse every by-product as raw materials and ecreate theminto superior scene materials and functioning materials, this is our contribution to society.

We always strive to acheive the next step in keeping the enviroment "as it is" for the future.

Eco Products for Landscape and Garden

Earthen Techno

KAMEI SEITO Co.Ltd.

www.eco-angels.com

″E″ is a keyword in the recycling society

"E's" motto is, "To produce a product Desirable For everyone; customers, manufacturers, discharge producers and the Earth.

Earth, Ecology, Environment, Education, Energy, Economy etc. - in the recycling society, where Natureand humans coexist, the keywords start with "E".

Across the field and in various situations, places and scenes, it is "E's" idea to build a network which links these "E's" organically, and to aim for arecycling society.

"E's" philosophy is to cherish to produce the product comfortably, not only for the sake of the development of the company, but also for the population and the Earth.

The commitment of using the Non-Firing Solidification Technology

無焼成・無排水・無廃棄

We have special patent technology called "the Non-Firing Solidification Technology".

This is a reclaiming technology, using various kinds of waste, to produce clean bricks and roadbed materials without baking. This is a low environmental impact recycling technology, that is carried out in seven plants within Japan.

On the other hand, in other Asian regions - China and India in particular, large economic growth is occurring, which is producing mass quantities of air pollution and waste that is difficult to manage.

The brick production volume in these areas constitutes approximately 80% of the world's total volume. Brick production creates large amounts of CO_2 waste, which is a significant factor in global warming, barren land issues and desertification.

The Non-Firing Solidification technology for producing bricks is an ideal form of recycling - with regards to resource protection, waste becomes the raw material of the brick, and to contribute towards the prevention of global warming, the product is not baked.

Now, we wrestle with many national businesses and are aiming to take "E" to "Global E".

Company profile

Earthen Techno（地球技術） 亀井製陶株式会社

Company name	Kamei Seito Co.,Ltd
Mission	「無焼成固化」技術で地球環境保全に貢献します。
Address	1258 Kasahara-cho Tajimi-shi Gifu, Japan TEL0081-572-43-3511　FAX0081-572-43-6815
Established	1/1/1966
Capital	40,000,000yen
Business contents	● Production and wholesale of "Earthen Bricks" ● Collection of industrial waste transportation / intermediate processing(Recycling) ● import and sale building stones, Sue board, gardening materials and others ● Global development of the non-firing solidification technology
Employees	5
Bank	Japan Finance Corporation for Small and Medium Enterprise / Tono Shinkin Bank / Ogaki Kyoritsu Bank / The Bank of Tokyo-Mitsubishi UFJ,Ltd. / 16 Bank and Others
President	Hiroaki Kamei
Collaborative relationship	・Tokyo Electric Power Company ・Marubeni Corpration ・Takahama Industry Co., Ltd. ・Nagoya Institute of Technology ・Alced Co. ・Tepia Co. ・Eco Business Network and Others

Although they are non-fired, they are very safe, high quality and low price.

Sewer sludge, burned ash, coal ash, ceramics abolished soil [Kira], molten slag, glass waste and many other unused resources are utilized, and are regenerated to form a revolutionary brick style block, without baking, using our special slodificaton technology (Patent process).

We feel it is important to create materials of soft disposition, that feel like ceramics, which gives warmth and serenity to the cityscape.

Feature

◆ resource conservation

80% of the raw materials are made up from several kinds of by-products from other industries, which result in absolute zero emissions. It is possible to produce strong, stable, durable bricks of long term quality by utilizing the best mix of raw materials with their own individual qualities.

Gifu-ken waste recycling recognition product

◆ Circulation type

We reuse the inferior goods which come out of the manufacturing process as raw materials, and also, because of the non-firing technology, no CO_2 or factory draining watse is created. Furthermore, the products can be reclaimed as many times as possible after use.

Eco mark executive office recognition, environmental preservation commodity

◆ Energy conservation

Scrap materials without pretreatment can be used for raw materials, even without

firing. Due to the fact that the fossil fuel is not burnt, excessive processes are excluded, so the production is energy-saving and cost-saving.

◆ Safety

From the acceptance stage of the raw materials, of course to the finished product, the process conforms to strict physical properties standards and environmental standards. Furthermore, we execute the original released metal content test with Ph3, which is above and beyond the safety satndards.

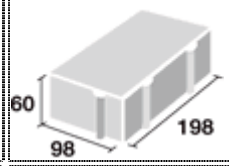
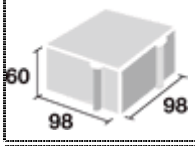
◆ Scenery characteristics

The product looks a little like antique bricks, due to the ceramic kneading technology that is applied, and they will continue to mature attractively over the coming years of use.

◆ Consideration type

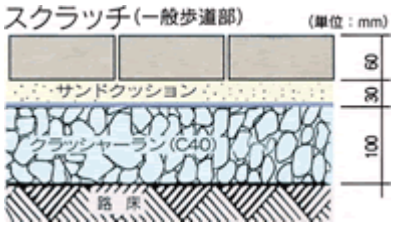
It is suitable for non slippy, comfortable, barrier free sidewalks. Furthermore, in order to produce good effects on vegetation and the living environment, special EM ceramics have been added to the raw materials.

Specification

Form		
Use quantity (bricks/m²)	50 bricks/m² (100x200)	100 bricks/m² (100x100)
Pallet loadage (bricks)	600 bricks/pt.	1200 bricks/pt.
Weight	Scratch(100x200) 2.3kg/brick	Scratch(100x100) 1.1kg/brick
	Scratch Cobolu (100x200 with round corner) 2.2kg/brick	Scratch Cobolu (100x100 with round coerner) 1.0kg/brick

We also produce different types of 50mm thick, without the lip.

Standard operation cross section diagram



Safety data

Item	result	metrical method
Released metal content test	conformity	18th environmental economical notification
Content test	conformity	19th environmental economical notification

Physical properties data

Item	physical properties	standard level	examination method
Flexural strength (Mpa)	8.2	5.0 or more	The interlocking block association method
Compressive strength (N/mm^2)	62.0	32 or more	Basis of JIS R 1250
Resistance abrasiveness (g)	0.098		Standard of JIS A 5209
Damp slide value of resistance (BPN)	76.3	40 or more	ASTM E-303
Frost damage resistance characteristic	No abnormality		Basis of JIS A 5209
Coefficient of permeability (permeability type)	$3.732*10^2$cm/sec	$1*10^2$cm/sec or more	Basis of JIS A 1218

The non-fired eco bricks which are produced from industrial waste

Our non-fired eco brick is produced by materials made from industrial waste. To regenerate various kinds of industrial waste to a brick-like block by "non-firing", "no disposal", "no drainage" production, which are the low-environmental-load, recycled bricks.

Materials for non-fired eco bricks

◆ **City rubbish melted slug (general waste incineration melted slug)**
Incinerates general home "burned rubbish" to stabilize (shut in) the harmful matter, which is melted at high temperature (melting) to vitrified slug (sandly).

◆ **Sewer sludge ash (feces, urine and other careless drainage waste ash)**
There are two types of sewage which are the branch system and the confluence system. The branch system is the waste water, feces and urine from homes, and the confluence system is when the branch system waste and the rainwater that fell in the urban district flow together. The sludge ash is the sludge, after microbe processing, and incinerated to reduce capacity to minute powdered ash.

◆ **Waterworks sludge**
beverage service water purification remaining earth

◆ **Coal ash < fly ash: FA>**
coal thermal power burned ash

◆ **Glass cullet (pulverized glass, such as glass packing container)**
Among the glass bottles which are disposed of, mainly from general homes, is glass which cannot be recycled < shattered bottles of import wine and bottles of cosmetics, are examples > these are ground into sand condsistency (the cullet).

◆ **Paper sludge ash <PS ash > (waste paper, recycling by-product ash)**
During the processing of waste paper to make the recycled paper, the old ink and clay

which is contained in the paper, is discharged as sludge. After chemical treatment, the capacity is decreased by incineration to minute powdered ash.

◆ Minute silica sand < [kira] > (glass ceramics raw materials extraction process by-product)

The powdered sand which remains after extracting, from the minerals, the silica sand which become the raw material of glass and clay which make ceramics (the mountain soil which becomes the raw materials)

◆ Quarrying waste soil (remaining soil after extraction of gravel)

It is discharged in the extraction of mountain gravel and mountain sand. There are two manufacturing methods that discharge them, which are the wet process and the dry process. The wet process is the main discharger of waste.The the gravel and sand is washed and put through the filter press (the dehydrator) to eliminate clay sludge. (The stone dust which is discharged during the dry process can also be used)

◆ Cupola slug (metal industrial waste)

This is the slug which is discharged from automobil parts factories. The slug is discharged by using the blast furnace, which is called the cupola, to discharge the pig iron (dissolved iron), which is melted with high temperatures to a mud condition that is removed directly in water, becoming sand condition.

◆ Foundry sand or Cast-metal sand(metal industrial waste)

This is the fine sand which is used in order to form cast-metal.

◆ Dam, lake and pond bottom mud (accumulation sludge)

This is the sludge which has sunk to the bottom of dams, lakes and ponds, containing the organic matter. Its state varies, depending on the surrounding environment.

◆ Waste gypsum (pulverized gypsum board)

This is formed when gypsum board from constructive scrap is pulverized to white powder, to remove paper and rubber, etc and extract gypsum.

◆ House manufacturer external wall material rubbish (cement type pulverization or sludge)

This is the waste produced when major residential manufacturers pulverize the external wall and edge materials from the demolition of the original residence, in order reuse materials of cement type etc.

◆ Bentonite mud (civil engineering works scrap material)

This is the used mud of sealed construction and post construction bentonite (clay).

◆ Volcanic ash

volcanic ash such as Mt. Usu and Fugen peak

◆ Used pearlite

Incinerating pearlite, which is used as an absorbant, converts it to inorganic and makes it minute powder.

◆ The slaked lime sludge

The slaked lime sludge which occurs at the time of carbide production.

◆ Rock wool (silica calcium) waste

The waste of rock wool heat insulator used in furnace walls

◆ Plastic waste, FRP pulverization

◆ Construction site outbreak remaining soil

The remaining soil which occurs during construction works and civil engineering works

◆ Others

In addition, cinder, burning shell,inorganic characteristic sludge, dust, ore occasion, glass ceramic ware rubbish, plastic waste

Our products can be purchased in Eco-Angels stores. In addition, please do not hesitate to contact us if you have any further questions.

Original Products

Garden bricks Eco-product

Sewer grime destruction by fire ash, coal ash, ceramics abolished soil " Kira ", molten slag, glass waste and many other unused resources are utilized, and are regenerated to form a revolutionary brick style block, without baking, using our special slodificaton technology (Patent process).

Washed gravel, makeup gravel, paving gravel Eco-product

Ceramic raw matrials are a by-product of washed gravel, makeup gravel and paving gravel which are necessities in gardening products in order to enjoy a variety of colors and to strengthen the groundwork of garden soil.

Weed prevention products / The prevention of weeds

Are you having a problem with weeds that grow with out limitation? The simple execution of "Grass Feud" can confine weeds with a compressed strength of more than 12N/mm2, while there is permeability.

Imported products

Flat board / Sue board

These are gardening quotient materials that can be easily used to the accent the garden, the driveway, or the entrance. Please coordinate color and design preference to an image of the garden.

The garden paving stone

The building stone series of granite (domestic production) comes in a variety of sizes and two basic colors - white and rust. They are of superior durability and create a grand atmosphere.

Gardening exterior

The gardening exterior plays an active part in the finishing touches and accent of the garden. There are numerous exterior goods which would fit for the entrance, driveway, garden and others.

Buffer stop/ Bumper/ (Parking block)

The parking block is used widely in parking lots in public spaces, such as parks and hospitals. They are sturdy and dur

able and installation is simple

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

Affiliation	SHIMIZU CORPORATION	
Location	2-16-1 Kyobashi, Chuo-ku, Tokyo 104-8370	
Position:	Tokyo Branch Building 1st Section Tokyo Big Site Eastern Temporary Exhibition Hall Construction Project Director	
Name/Surname	ETSUMASA YAMADA	
e-mail	essay.yamada@shimz.co.jp	
Title	**Construction project of temporary exhibition hall on the eastern side of Tokyo Big Site ~ Construction project of 100% recycling exhibition hall that can be easily removed ~**	
Theme classification	○	Prevention
		Re-use
		Recycle
		Reduce Co2
		Legacy
		Business to overseas
		Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020
Specific content	-This project is an Olympic-Paralympic-related facility. And it was ordered with the design build method of design and construction bulk order including technical proposal considering to be removed and used for about 10 years after construction - We also built eco-friendly buildings that can be recycled, minimizing environmental impacts in new construction work and future demolition work. - At this site, we adopted a pile head ring socket (developed by our company) which eliminated the underground beam for all foundations - We are also assuming that steel pipe piles will be drawn and reused in the future. The upper structure adopts a pure steel structure, double folded roof and outer wall ALC, both of which can be recycled.	
Appeal point	- Efforts to 3R ,especially waste prevention of large-scale buildings from the planning stage are the first in Japan. - Construction production activities are multi-varieties and one product production, there is not the same building as one, the production place also changes every time, the lifetime visits someday in any building someday, its role ends - As in the construction work of this case, there are rare cases where 3Rs could be promoted from design to construction to removal of dismantling. I hope that by transmitting this content, such efforts will increase	

Project for Construction of a Temporary Exhibition Hall on the East Side of Tokyo Big Site

Construction of an exhibition hall, which is constructed totally from recycled materials and can be readily removed

1. Introduction

As the existing exhibition hall at Tokyo Big Site cannot be used for about ten years because of large-scale rehabilitation work, a temporary exhibition hall was planned to enable various events to be held continuously.

Photo 1 whole exhibition hall

The design and build contract was used for this project which orders design and construction as a package. As a result of comprehensive evaluation, we were awarded the project.

In our technical proposal, we proposed construction of Eco Building, which would use recycled materials at high ratio and would be environmentally friendly because this building would be removed after use for about 10 years.

2. Outline of the Building

Location	Within the lot of Tokyo Big Site, 3-10-1 Ariake, Koto-ku, Tokyo
Lot area	124,186.54m^2
Total floor area	19,905.m^2
Scale	Two stories above ground
Building height	16.44m
Application	Exhibition hall
Structure	Steel frame structure
Construction period	November 2015 to October 2016

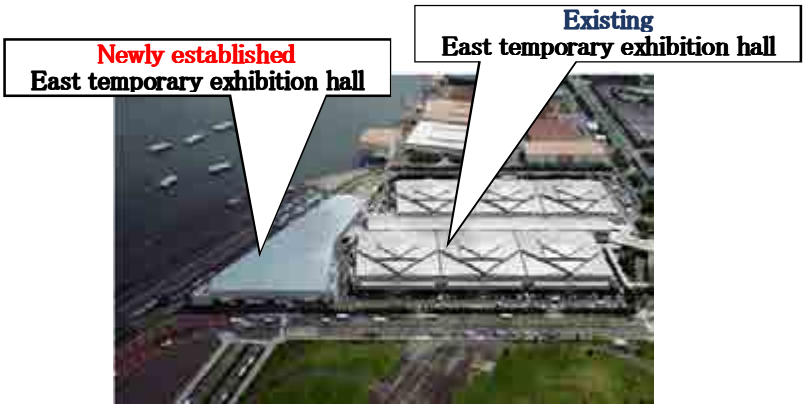


Photo 2 Exhibition Hall

l

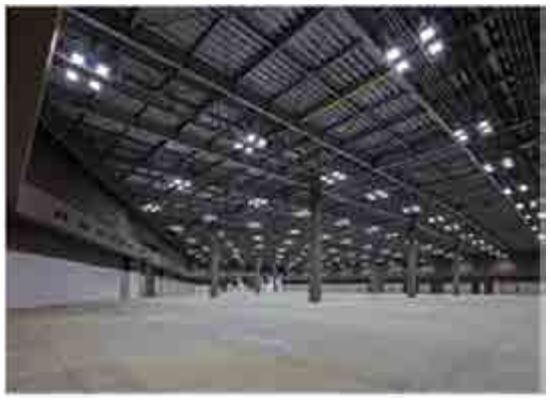


Photo 3 inside the exhibition hall

3. Employment of a steel-pipe piles rotary jacking method, which ensures easy removal (design stage)

A steel-pipe pile rotary jacking method is to jack steel-pipe piles while rotating them. As shown in Figure 1, a circular blade is installed at the front end of steel-pipe pile, and both the pile and blade rotate to cut into the ground.

Fig.1 Tip of steel pipe pile

For removal,
the pile is turned in an opposite direction
to facilitate easy withdrawal. (Figure 2)

Figure 2 Structure of pile removal

This is an environmentally-friendly method
with the minimum noise and vibration,
which does not generate any sludge.
In addition,
steel-pipe piles that are used can be totally reused
and recycled after removal.
Since the pile jacking depth to the pile bearing stratum
is 70 m underground.
Namely this work method involves extreme difficulty
because pile off-center must be prevented positively
to secure the quality.

Photo -4 Steel pipe pile construction situation

4. Employment of a pile-head ring socket method that does not require underground suppor
(design stage)

A pile-head ring socket method is our unique patented method, in which steel-pipe piles and steel column legs are formed into a solid system by surrounding them with outer steel pipes and filling the gap with concrete. Figure 3 shows a sectional view of the building. As shown in the figure, the head of steel-pipe piles and legs of steel frame column are jointed.

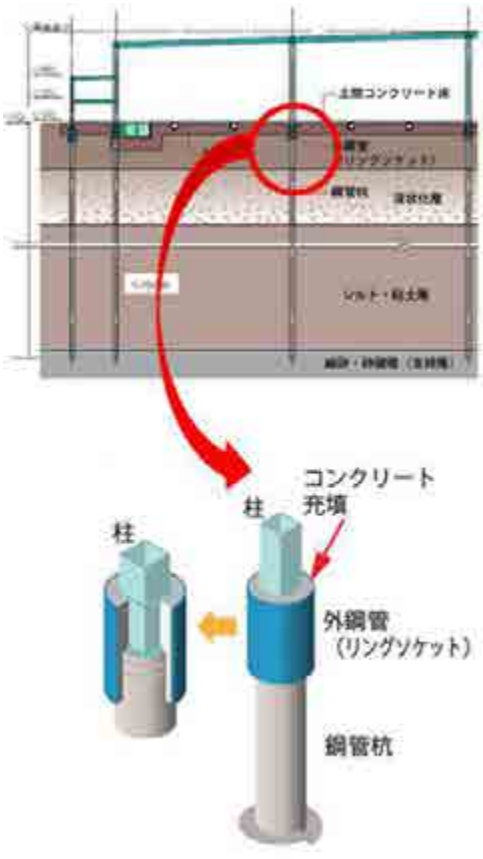


Figure 3 Sectional view of building and pile head ring socket

This method enables the piles to bear the stress from the column legs, which in turn can eliminate the underground support and foundation. This can reduce excavated soil and concrete mass volumes substantially and thus CO2 emission and wastes.

Photo 5 - Installation status of ring socket

Photo-6 Concrete Filling Status

5. Employment of recyclable members (design stage)

The walls of about 2,650 t of steels are of a suspended structure to allow for subsidence and are capable of recycling. The outer wall is made from ALC and metal plates. ALC of about 8,760 ㎡ is also totally recyclable. When disassembled as units during removal, the steels and ALC plates of outer walls can be reused as they are. For the roof of about 17,000 ㎡, the double folded-plate roof with sandwiched heat-insulation glass wool is employed, which is totally recyclable.

Photo-7 External wall steel construction situation

Photo-8 ALC Board Construction Status

Photo-9 Roof construction situation

6. Conclusion

Construction production activities are multi-varieties and one product production, there is not the same building as one, the production place also changes every time, the lifetime visits someday in any building someday, its role ends

As in the construction work of this case, there are rare cases where 3Rs could be promoted from design to construction to removal of dismantling. I hope that by transmitting this content, such efforts will increase

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

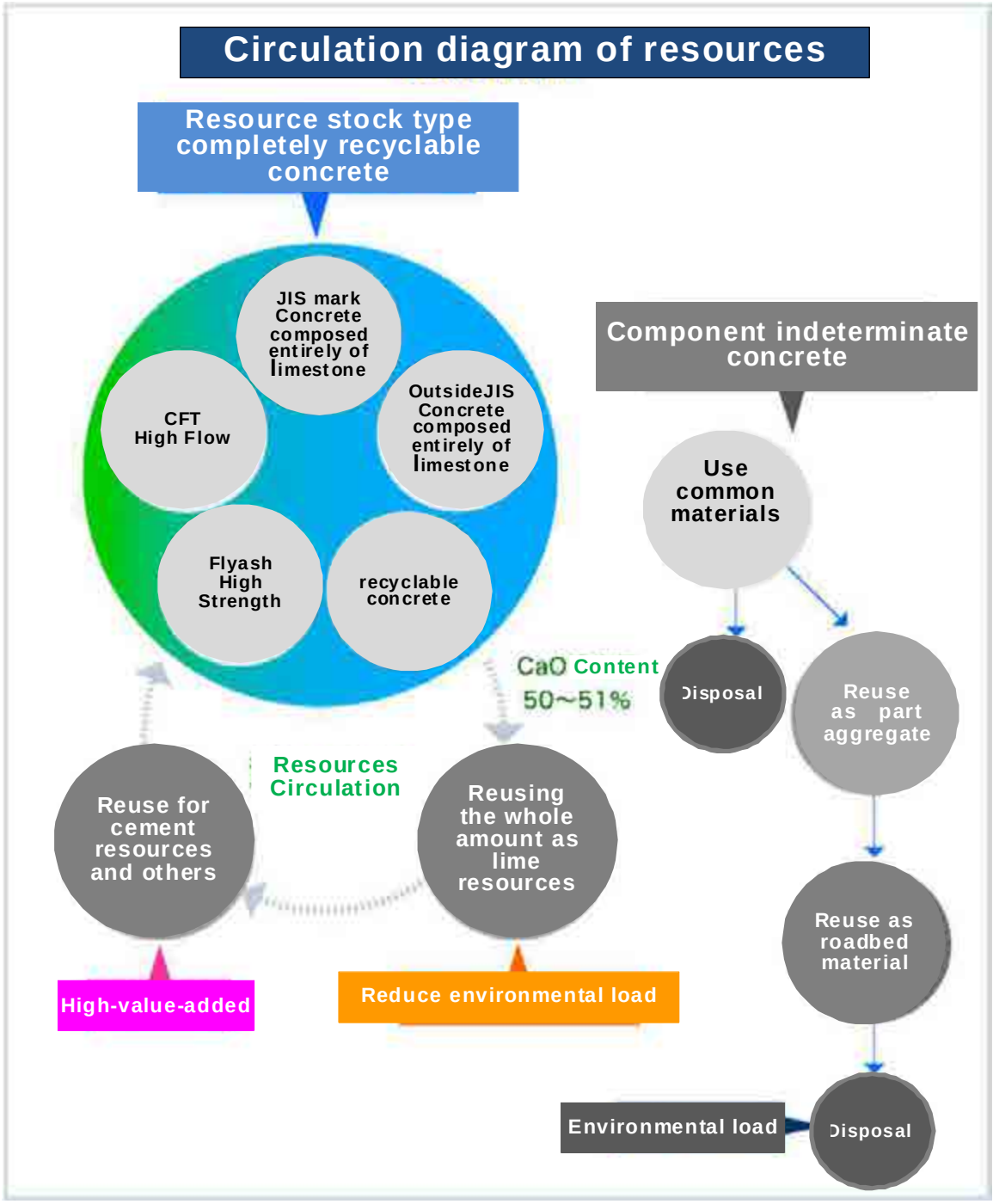
Affiliation	TOUZAKI Co.,Ltd	
Location	1-8-12 Shikahone Edogawa-ku, Tokyo 133-0031	
Position:	CEO	
Name/Surname	TADASHI TOUZAKI	
e-mail	tadashi@touzaki.co.jp	
Title	**Resource stock type Completely Recyclable Concrete (Concrete using limestone aggregate as the total amount of aggregate)**	
Theme classification		Prevention
		Re-use
	○	Recycle
		Reduce Co2
		Legacy
		Business to overseas
		Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020
Specific content	- “Resource stock type Completely Recyclable Concrete” produced using only high-quality limestone aggregate and limestone crushed sand with chemical components confirmed, concrete itself becomes high-quality calcareous resources. -If you bake the concrete waste unprocessed raw as it is, it will be transformed into high-quality cement raw materials. That is, the concrete waste will be used as a raw material for cement. -Touzaki Co., Ltd. continues to make concrete that demonstrates its true value 100 years later in the form of high quality as well as "resource stock to the future"	
Appeal point	- As "closed loop recycling" of concrete waste, Concrete waste will be cement raw materials without processing.	

Resource stock type Completely Recyclable Concrete

(Concrete using limestone aggregate as the total amount of aggregate)

1. OUTLINE

"Resource stock type Completely Recyclable Concrete " embodies the concept and technology of "completely recyclable concrete" advocated by Professor Takafumi Noguchi of the University of Tokyo



2. FEATURES

(1) High durability

①Alkali aggregate not reactive

·Alkali silica reaction

Suppression of Alkali Aggregate Reaction (Civil Engineering , Building)
Implementation Procedure

·Alkali carbonate reaction

Cement Association Concrete Special Committee Report F·47

②Less drying shrinkage

⇒ According to the company's annual seasonal variation survey
(average = less than 600 μ)
(The examination is requested to the building materials testing center)

③The linear expansion coefficient α of limestone is small (about 5 μ / ° C.)

⇒ It can be expected to suppress temperature cracking

(2) Less pumping loss

·It does not contain silt (viscosity) in the fine powder part

↓

·There is no excess adsorption of chemical admixture and moisture

↓

·Less slump loss due to pump pumping

(3)Concrete waste is resource

·After dismantling the structure, the concrete waste generated

↓

·Reusable as cement raw material

(Completely Recyclable Concrete = Resource Stock Type Completely Recyclable Concrete)

(4) Fully compatible with ready mixed concrete (JIS A 5308)

(5) Acquired Ministerial Certification on High Strength Concrete

·Acquired Ministerial Certification on High Strength Concrete alone at factory (2010.2)
(Certification scope: moderate heat cement · design standard strength 80 N / mm 2)

·By actual machine tests, it was confirmed that compression strength of 120 N / mm 2 could be achieved even with concrete using limestone for the total amount of aggregate

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

Affiliation	SEIYUKOGYO Co.,Ltd	
Location	1141-1 Kusabana , Akiruno ,Tokyo 197-0802, Japan	
Position:	CEO	
Name/Surname	MASAHITO HOSONUMA	
e-mail	m.hosonuma@seiyukogyo.co.jp	
Title	**Recycling Technology of construction sludge**	
Theme classification		Prevention
		Re-use
	○	Recycle
		Reduce Co2
		Legacy
		Business to overseas
		Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020
Specific content	- The processing system of Sekiyu Kogyo Co., Ltd.'s Jonanjima No.2 Factory, which was completed in December 2016, is a highly integrated processing system of the latest knowledge. The processing system consists of two technologies. One is the latest Silt dehyder technology as an appropriate treatment method to grasp the physical and chemical properties of the object, and the second is desalination technology combining micro bubbles and CO 2. - With the new technology of Silt dehyder, the mechanical classification point of existing cleaning technology in soil, mud, etc. was 75 μm (0.075 mm), but it was possible to set the mechanical classification point to 32 μm (0.032 mm).	
Appeal point		

Recycling Technology of construction sludge

1. Outline of Jonanjima No.2 Plant

In December 2016, the Jonanjima No.2 Plant of Seiyu Kogyo Co., Ltd was completed, which had introduced an advanced cleaning system.

Jonanjima No.2 plant full view

(3-2-11 Jonan-jima, Ota-ku, Tokyo)

Site area: 8,867 m 2 Building area: 2,699 m 2

Greening area: 1,250 m 3

Underground storage tank: 1,225 m 3

Industrial waste disposal facilities

－Crushing facilities

Incoming materials: Cinders, rubble, mixed wastes (plastics wastes, rubbers wastes, scraps, waste textiles, glass wastes, concrete wastes, and ceramics wastes)

Throughput: 2,880 t/day

－Dewatering facilities

Incoming materials: Sludge (inorganic only)

Throughput: 1,076m^3/day × 2 units

－Pelletizing solidification facilities

Incoming materials: Sludge, cinders, rubble, mixed wastes (plastics wastes, rubbers wastes, scraps, waste textiles, glass wastes, concrete wastes, and ceramics wastes)

Throughput: 1,440m^3/day

Contaminated soil treatment facilities

Type of facilities and treatment capacity:

Cleaning and other treatment facilities (cleaning (extraction, washing) 120 t/h 2,880 t/day

Cleaning and other treatment facilities (insolubilization) 60 m^3/h 1,440m^3/ day

Screening and other treatment facilities (removal of foreign materials) 80 m^3/h 1,920 ㎥/day

Screening and other facilities (moisture content control) 60 m^3/h 1,440 ㎥/day

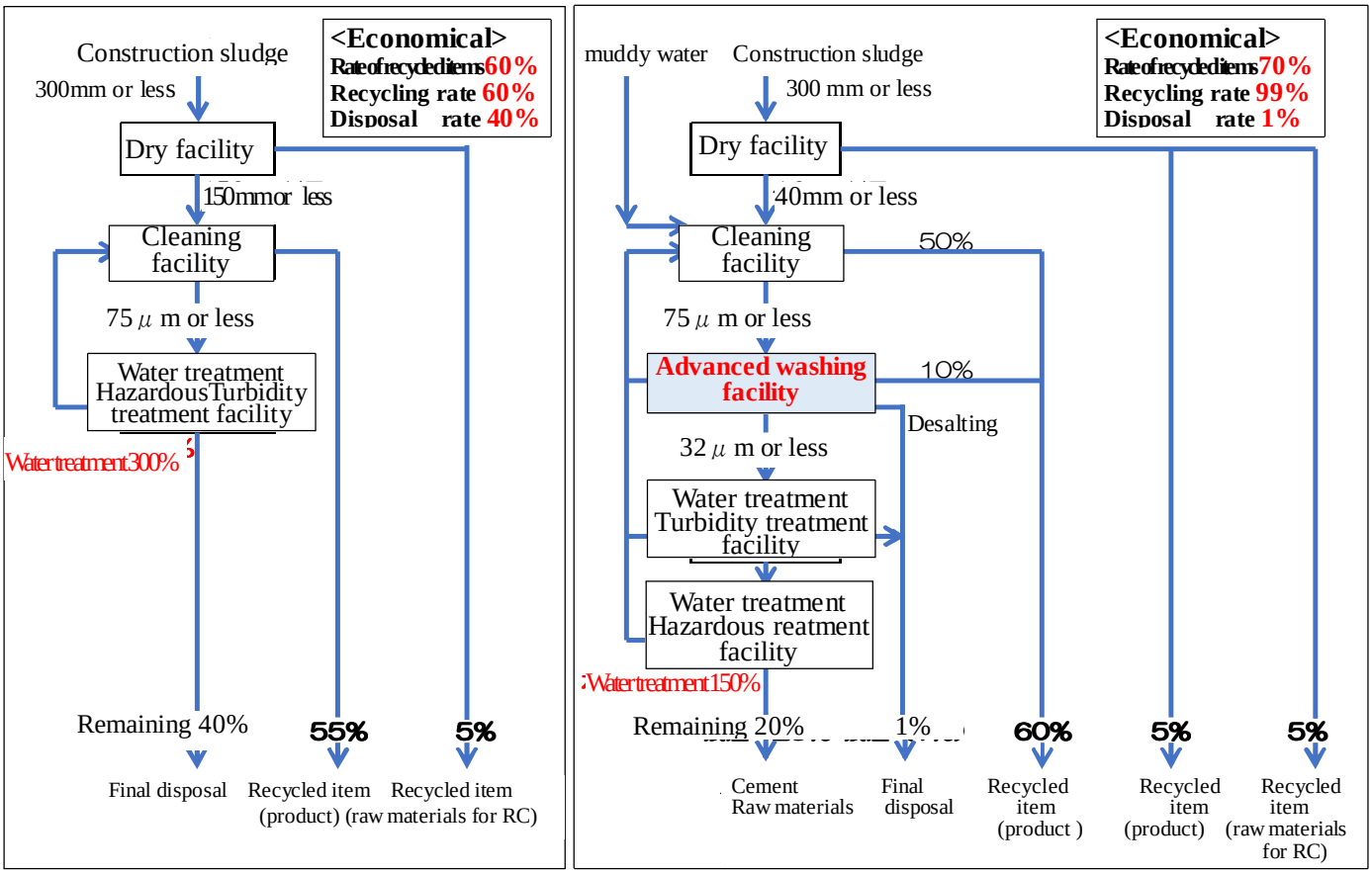
The advanced technology, which has incorporated a Silt dehyder , is a treatment system in which latest findings are integrated at high level. Such findings are the adequate treatment process based on understanding of physical and chemical characteristics of materials to be treated, the demineralization technology in which micro bubbles are combined with CO_2, etc. Though the mechanical classification point in terms of soil and sludge with the conventional cleaning technology was 75μm (0.075mm), a new technology with Silt dehyder has achieved a mechanical classification point of 32μm (0.032mm).

2. New technologies

2-1. Silt dehyder

Silt dehyder is a system achieving substantial improvement of the cleaning accuracy of soil, etc. by adding the silt cleaner to the conventional Silt dehyder.

Silt dehyder



Conventional plant **Silt dehyder plant**

The mechanical classification point in terms of mud with the conventional cleaning technology was 75μm (0.075mm), which can be improved to 32μm (0.032mm) with Silt dehyder. In the case of conventional cleaning technology, the dewatered cake production rate is 27.9% when the grain size is 75μm or less. This facility can recover further one third of mud as product (fine sand) at the grain size of 75μm or less.

2-2. Cleaning with carbonic-acid micro-bubbles

Conventional water cleaning could not remove chlorine solidified in inorganic mines of incineration ashes, etc. Carbonic-acid micro-bubble cleaning proved capable of demineralization.

3. Future overview

No.2 Plant is a critical hub site to consider the greater resources recycling including us. We will make efforts for cooperative challenging with other treatment companies in Tokyo Super Eco Town.

This facility is also capable of handling disaster rubble from great inland earthquake and heavy rainfall whose occurrence is expected and of wastes treatment containing soils, specifically chlorine. In case of emergencies, we are confident that this facility will contribute to rapid disaster rehabilitation and recovery of urban functions.

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

Affiliation	Hanshin Expressway Co., Ltd, Japan	
Location	Sankyo Sakai East bldg..5F 2-3-20 hanadacho minami-ku, Sakai, OOSAKA, Japan	
Position:	Construction Manager , Sakai Construction Department ,Construction Management Headquarters	
Name/Surname	Muneyuki Yamana	
e-mail	muneyuki-yamana@hanshin-exp.co.jp	
Title	**"Joint Project for Effective Reuse of the Soils" Effective utilization of shield tunnel construction sludge using tracing technology**	
Theme classification		Prevention
		Re-use
	○	Recycle
		Reduce Co2
		Legacy
		Business to overseas
		Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020
Specific content	-"Joint Project for Effective Reuse of the Soils" implemented in Osaka, in which a couple of big construction projects, Hanshin Expressway Yamatogawa Line construction by shield tunneling and coastal reclamation, were integrally planned and managed to effectively utilize 0.95 million m3 of excavated soils (construction sludge) from the shield tunneling as reclamation material. -"Joint Project for Effective Reuse of the Soils" has been demonstrated to have many advantages such as effective use of resources, proper disposal of construction sludge, prolongation of life of final disposal site, reduction of CO2, reduction of project cost.	
Appeal point	-"Joint Project for Effective Reuse of the Soils" is a case example of advanced model for effective utilization of construction sludge making use of ITS, including improvement of traceability of industrial waste transportation, prevention of environmental pollution by illegal dumping, prolongation of life of public final disposal site, reduction of environmental burden, reduction of business cost, promotion of effective utilization of construction sludge in the future, leading to the establishment and sustainment of a recycling-oriented society in the future is expected.	

Effective utilization of shield tunnel construction sludge using tracing technology

Muneyuki Yamana[1*], Yasuo Tomizawa[2], Manabu Inagaki[3], Kazuma Mizuta[3], Katsumi Mizuno[4], Takeshi Katsumi[5], Toru Inui[5] and Masashi Kamon[6]

[1] *Hanshin Expressway Co., Ltd, Japan*
[2] *Hanshin Expressway Engineering Co., Ltd, Japan*
[3] *Environmental Management and Technology Center, Japan*
[4] *Osaka Bentonite Business cooperative, Japan*
[5] *Graduate School of Global Environmental Studies, Kyoto University, Japan*
[6] *Research Institute for Environmental Geotechnics, Japan*

ABSTRACT: This paper addresses "Joint Project for Effective Reuse of the Soils" implemented in Osaka, in which a couple of big construction projects, Hanshin Expressway Yamatogawa Line construction by shield tunneling and coastal reclamation, were integrally planned and managed to effectively utilize 0.95 million m^3 of excavated soils (construction sludge) from the shield tunneling as reclamation material. In this joint project, management of such a huge amount of soils transported between the highway construction site, the soil treatment facility, and the reclamation site was a key issue. For the transportation of this large quantity of shielded construction soil, we created a fully electronic manifest system by utilizing the ETC vehicle authentication function and GPS information. The newly developed ETC manifest system was used in order to issue and store manifests on the same day that the operation took place. This system has improved the traceability of transporting a large amount of generated soil, and ensured the transparency of construction sludge recycling, which led to significant savings in the creation of manifests.

Keywords: Excavated soil, Tracing technology, ETC manifest system

1. INTRODUCTION

A “Joint Project for Effective Reuse of the Soils” was implemented in order to reclaim and utilize the excavated soils generated through mud-pressure shield tunnel construction at the Hanshin Expressway Yamatogawa Line as reclamation material for the No. 6 Lumber Yard Development Project, which is managed by the Ports and Harbors Bureau, Osaka City. The transportation of these excavated soils was equivalent to load of 158,000 units of dump trucks with a capacity of 10 t (approximately 500 units per day). The soils generated through the shield tunnel excavation were required to be managed as “construction sludge,” which is categorized to "industrial waste" according to the local regulation. In Japan, the delivery of the industrial waste management slips (manifests) has been mandated, and entails a series of process control procedures, from the generation to the landfill of industrial waste. However, the management of manifests, at sites where a large amount of industrial waste is discharged, is burdensome because it entails the delivery and counting of slips by collection companies, collecting carriers, and processing companies, in addition to the obligation of storing the manifests for five years. Moreover, with regard to paper slip management, problems such as the omission of entries, alteration, spoofing, and loss have occurred. Therefore, in this project, to improve the traceability of industrial waste movement, and to prevent environmental contamination by illegal dumping, the ETC manifest system was introduced in operations such as generation, transportation, acceptance, and reclamation of generated soil, and in manifest management. Thereby, ensuring the transparency of the recycling process was attempted.

In this paper, an outline of "Joint Project for Effective Reuse of the Soils" is presented in Section 2. The ETC manifest system introduced in this project is outlined in Chapter 3. The operation management procedure wherein this system was used is outlined in Section 4. Finally, an overall summary of this study is provided in Section 5.

* Corresponding author
Tel.: +81 72 226 4738; fax: 81 72 233 5730, muneyuki-yamana@hanshin-exp.co.jp

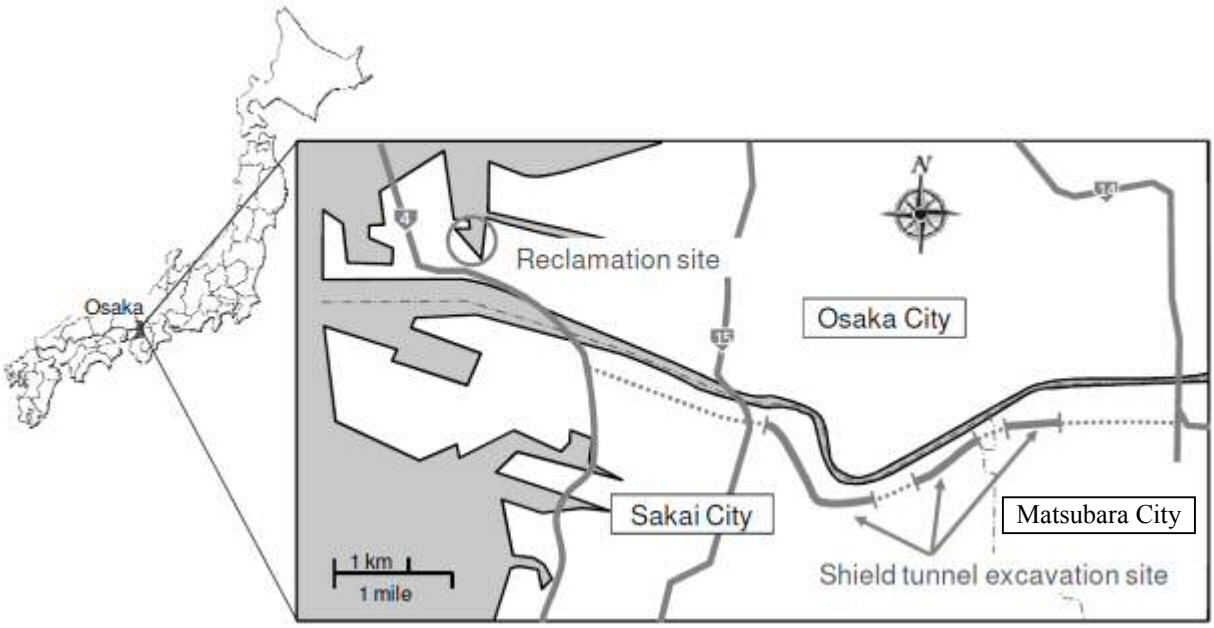


Figure 1. Project site locations [1)]

Figure 2. No.6 Lumber Yard (before the project)

2. JOINT PROJECT FOR EFFECTIVE REUSE OF THE SOILS

Most of the length of the 9.7 km Hanshin Expressway Yamatogawa Line is an underground structure, and approximately 40% of it was constructed by the mud pressure shield tunnel excavation method. Since the soil produced by this method is typically regarded as industrial waste (construction sludge) in Japan, it is commonly carried out to a site where it is finally disposed. However, this results in excessive disposal cost. In this project, recycling treatment (reforming treatment by neutral solidification and classification washing treatment) was applied to a large amount of construction sludge amounting to approximately 950,000 m^3, which

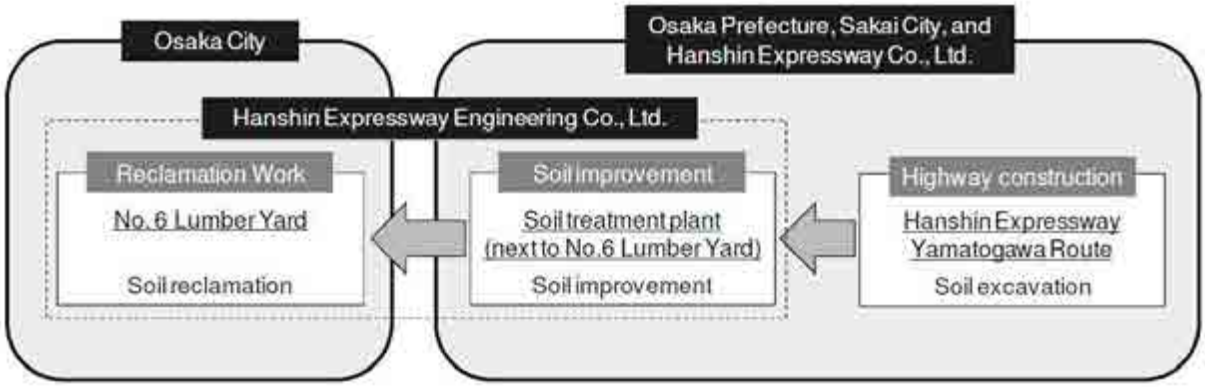


Figure 3. Scheme of joint project [1)]

was discharged from multiple shield tunnel construction sites, and used effectively as sea level reclamation material in the No. 6 Lumber Yard Development Project of the Ports and Harbors Bureau, Osaka City. Such joint management of different projects was attempted for the first time in Japan. Coastal reclamation was conducted in order to fill an area of 8.3 ha, which was previously used as an old lumber yard and is expected to make good use of the space. The excavated soils were subjected to soil improvement in order to be used as reclamation material ($>$400 kN/m^2 in cone index, and 6.0 - 9.0 in pH). A gypsum-based stabilizing agent was applied in order to maintain the pH of the improved soil lower than 9.0.

As a result, this will not only enable the proper and effective utilization of construction sludge at a low recycling rate, which is considered as a geotechnical engineering problem in Japan, but it will also extend the life of the final disposal site and reduce the emissions of CO_2 and cost of disposal. Additionally, many other advantages have been demonstrated [2)].

3. DEVELOPMENT AND SUPERIORITY OF ETC ELECTRONIC MANIFEST SYSTEM

As a new manifest registration mechanism to improve the traceability of industrial waste movement and to prevent environmental contamination by illegal dumping, the radio communication of the electronic toll collection system (ETC) was used in the ETC electronic manifest system. This system has been recently developed in order to generate

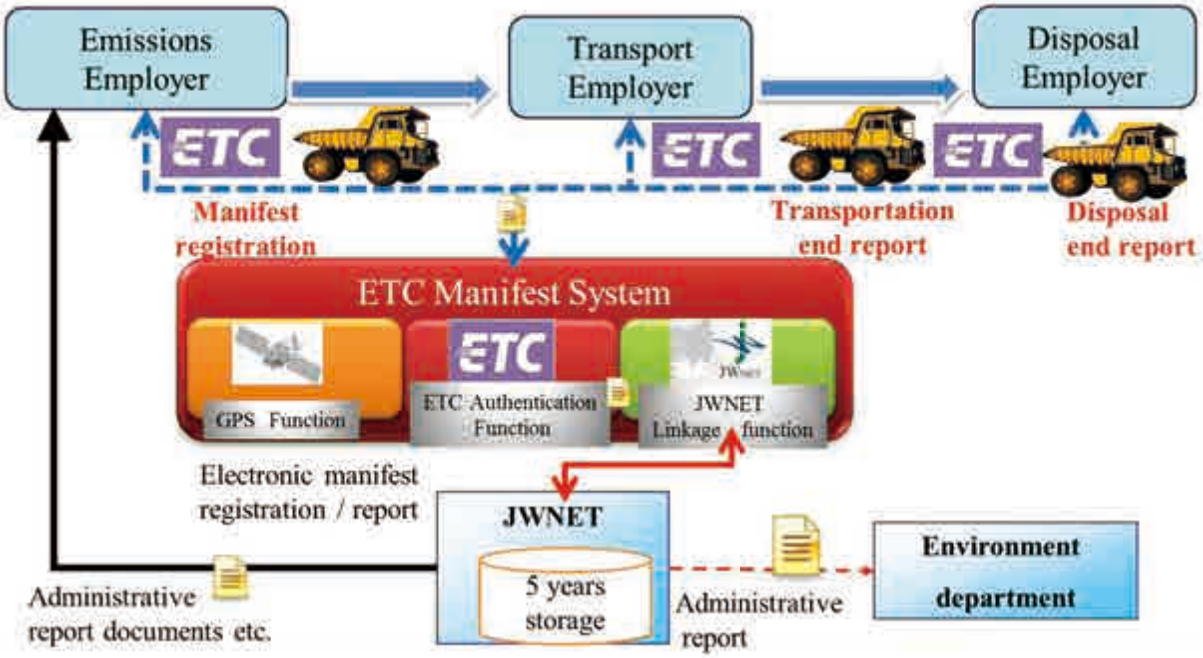


Figure 4. ETC (electronic toll collection) manifest system

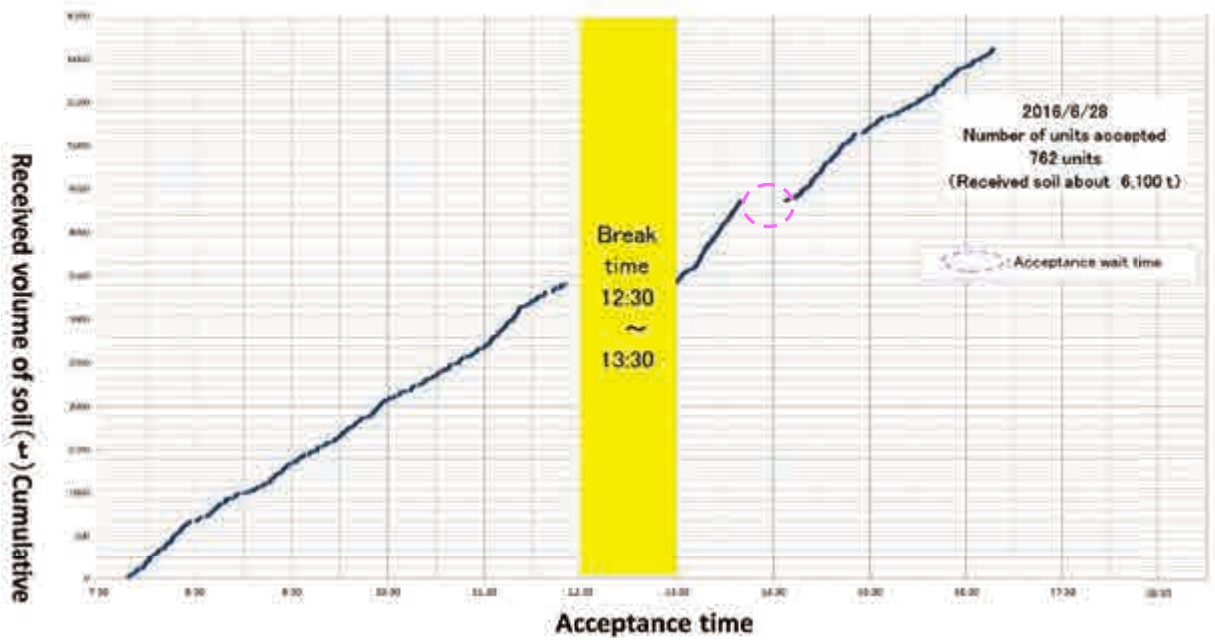


Figure 5. Operation control chart by ETC manifest system (number of maximum acceptance days)

electronic manifests (Figure 4). These electronic manifests were generated by the ETC certification of the transported soils generated through shield tunnel excavations entrance and exit records at each site. The system managed the electronic manifest in cooperation with JWNET, which is the abbreviation of "Japan Waste Network" and the electronic manifest system prescribed by the Japanese waste disposal legislation. Additionally, with regard to the transportation of the soils discharged from shield tunnel excavation, the management of transportation routes is instructed, standing by and detouring at times of congestion, ensuring that emergencies are communicated by the onboard global positioning system (GPS), and generally aimed for an overall appropriate and smooth work flow [3]. By the introduction of this system, the following advantages were gained:

(1) The load measurement (from the truck scale boarding to the weighing, ETC vehicle certification, etc.) lasted for approximately 10 seconds. Therefore, it was possible to reduce the vehicle waiting time in the vicinity of the on-site gate by 500 transport vehicles per day and a significant shortening was achieved.

(2) With regard to emission projects, education for drivers requires only simple practical training, and there is no need to input the operation by a personal computer or similar means. Therefore, the efficiency of making electronic manifests was increased, and very few operation errors by human was occurred.

(3) Since only registered vehicles are authenticated by ETC, it was possible to prevent the intrusion of unauthorized vehicles and conduct operation management in real-time. Therefore, it was possible to identify the target vehicles and the locations where a vehicle broke down or a traffic accident occurred. Additionally, the surrounding traffic congestion situation was assessed effectively, and also in real-time, which made it possible to respond to emergency situations promptly and ensure the reliability of operation control. As a result, delays in the progress of the project were prevented.

4. OPERATION MANAGEMENT USING ETC ELECTRONIC MANIFEST SYSTEM

The graphs shown in Figs. 5 to 7 visualize the operation management data collected by the ETC manifest system during the three days period of accepting the excavated soils. The amount of soil received on each day can be seen in the figure which vertical axis represents cumulative amount of soil received in the recycling treatment facility. The measurement time is shown on the horizontal axis. In principle, the facility started accepting the soil every morning at 8:00. At this site, the soil was transported by the same transport vehicle over six to seven round trips from the multiple shield tunnel construction sites to the recycling treatment facility, which was approximately 6 to 9 km away. The soil was sent to the reclamation site by a belt conveyor or similar, and the construction of the embankment was carried out.

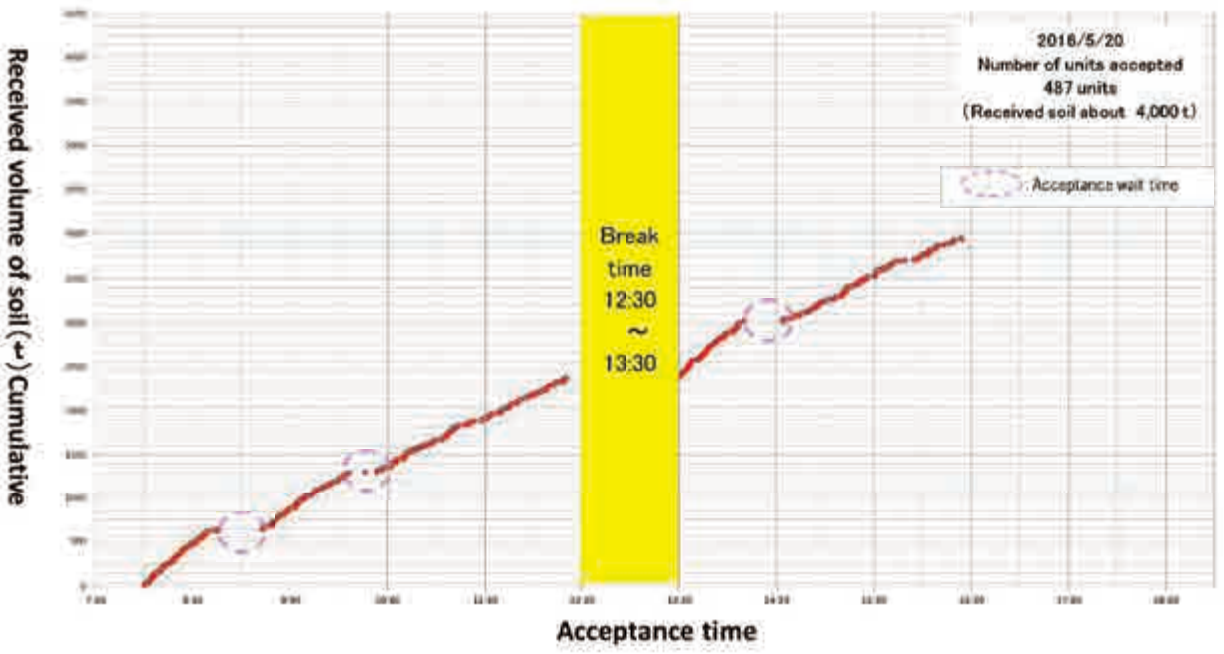


Figure 6. Operation control chart by ETC manifest system (examples of average acceptance days)

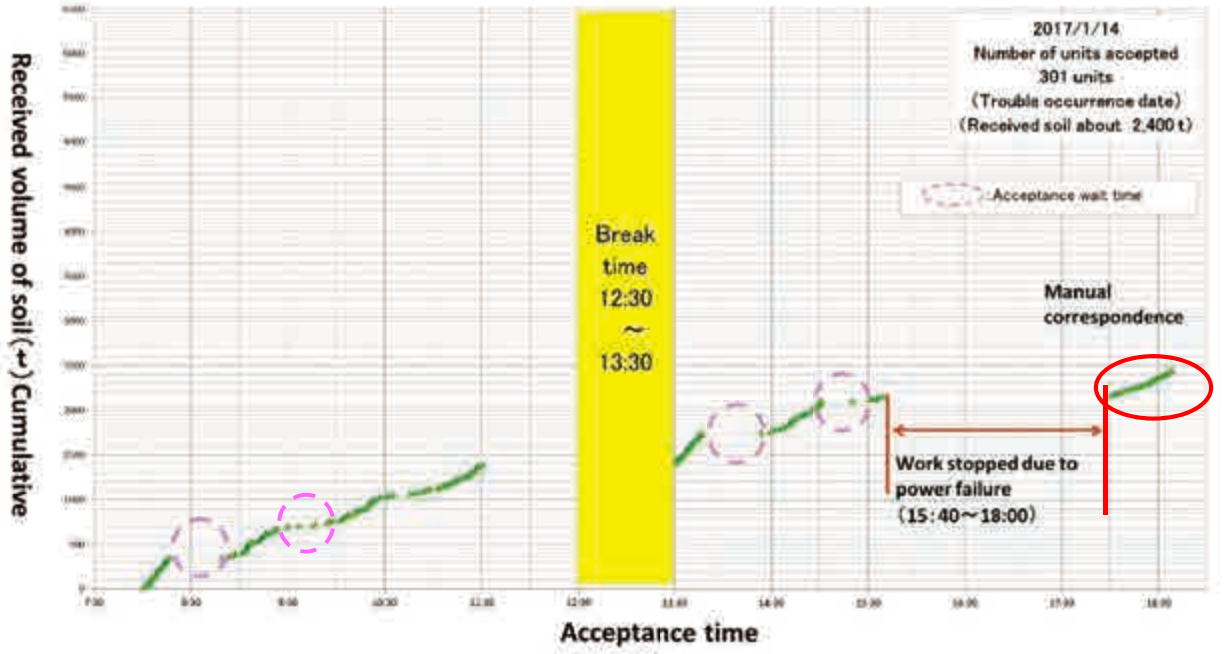


Figure 7. Operation control chart by ETC manifest system (examples of problematic days)

Figure 5 shows the day (June 28, 2016) on which 762 units were accepted. This was the largest amount of accepted units during this project. Total of 118 dump trucks prepared at two sites transported the material reciprocally and approximately 6,100 tons of the excavated soils were received. Transportation and acceptance were carried out efficiently, with the exception of a small waiting time for acceptance at approximately 14:10-14:30. However, it was some delay in process after acceptance of soil (recycling process, to reclamation), it did not affect the acceptance process and was able to accept the scheduled quantity of the excavated soils. Since the transportation vehicles gather early in the morning and afternoon from multiple sites, by shifting the start time and break time of one site, the waiting time of the transport vehicles around the facility was avoided.

Figure 6 shows one of a daily operation control chart when approximately 500 units as an average were accepted. A total of 109 units were arranged at the site and carried out transport back and forth.

Thereby, approximately 4,000 tons were accepted. Although there was a waiting time for acceptance at approximately 9:00, 10:15, and 14:00, it is thought that the standard number of receiving units was able to proceed to the next step of the process without difficulty.

Moreover, Fig. 7 shows an example of a day when trouble occurred. On that day, there was a power failure during the round-trip transportation with 43 vehicles arranged with a small number of 301 received cars, and we were only able to accept the scheduled amount of approximately 2,400 tons. The power outage occurred after 15:40, and acceptance was carried out by manual certification/weighing instead of electronic certification. The system was updated after the power was restored, which demonstrates the flexibly of the system to respond to the occurrence of problems. In this particular situation, the post-acceptance process was postponed for the next day.

In this way, by visualizing the weight data of the dump trucks and the time measured by the ETC electronic manifest system, it was possible to properly coordinate the transit vehicles and to efficiently manage the daily quantity of soil by accepting it in a reliable manner. The process and progress management of the entire project can also be useful.

5. SUMMARY

The newly developed ETC manifest system that was implemented in "Joint Project for Effective Reuse of the Soils" is introduced in this paper. This system makes effective use of the soils generated through shield tunnel excavation generated from highway projects and used as a reclamation material by land development businesses.

This system can be used as a technology to support transparency during the proper disposal of construction waste at mass emission sites. This system has many advantages, such as clarifying the responsibilities of each business operator, improving the efficiency of transportation management work, reducing labor, etc. Moreover, this system was evaluated and adopted in the management of vehicle operations during the East Japan great earthquake disaster. The ETC antenna was preliminarily installed in Gareki, which is located in the city of Kamaishi, in Iwate prefecture. The entrance and exit of the transport vehicles was recorded and the weighing control of the loads was carried out.

In this way, the system could be used in the large-area shielded tunnel construction of railways and roads, with a size of several millions of m^3, in the utilization of large-scale disaster waste as recyclable material, and in large-scale construction work in developing countries, for example. It is expected that the proper and effective utilization of construction waste will expand further and lead to the emergence of a recycling-oriented society in the future.

6. REFERENCES

1) Yamaguchi, Y., Mizuhara, K., Mizuta, K., Takemika, T., Katsumi, T. and Kamon, M.: “Management of the soils dischargrd from shield tunnel excavation using ETC system,” The International Workshop on ICT in Geo-Engineering, 2012,
2) Yamana, M., Kawamura, M., Tomizawa, Y., Inagaki, M., Mizuta, K., Uehara, K., Mizuno, K., Hamano, H., Katsumi, T. and Kamon, M.: “Hanshin Express Yamatogawa Line Development and operation of an integrated management system for shielding construction and utilization as landfill materials,” Proceedings of the 12th JGS Symposium on Environmental Geotechnology, pp. 91-96, 2017,
3) Tomizawa, Y., Yamaguchi, Y., Takemika, T., Mizuta, K., Fujiwara, T., Katsumi, T., Kamon, M.: “Application of traceability technology for reuse of construction waste - Case of the Hanshin Expressway Yamatogawa Line -,” Proceedings of the 10th JGS Symposium on Environmental Geotechnology, pp. 177-184, 2013

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

Affiliation	TAKATOSHI Co., Ltd	
Location	11-2 Arai-1choume　Nakano-ku ,Tokyo 165-0026, Japan	
Position:	Director of Planning & Development Department	
Name/Surname	KEIICHIRO NISHIDA	
e-mail	k-nishida@takatoshi.co.jp	
Title	**Improvement of recycling by high precision sorting of construction mixed waste**	
Theme classification		Prevention
		Re-use
	○	Recycle
		Reduce Co2
		Legacy
		Business to overseas
		Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020
Specific content	- System flow of "High precision sorted recycling system" - High-precision screening with the mixed construction wastes treatment line - Development of the technology for screening by color, which is to recover high-quality recycled crusher-run from mixed construction wastes	
Appeal point	-New technology was developed to identify glasses, bricks, rigid plastics, etc. by referring to minute color difference among them. For this purpose, the color screener appropriate for screening construction wastes, which have been developed in coordination with the dedicated color screener manufacturer, was combined with the non-ferrous metal screener.	

Efficiency Improvement of Recycling through High-precision Screening of Mixed Construction Wastes

1. Outline of the Tokyo Waterfront Area Eco-Plant Facility

Location: Jonanjima 3-2-15, Ota-ku, Tokyo

Structural scale: Intermediate treatment facilities Steel construction ・ Height 26m

Office building: Reinforced concrete construction, six storied ・ Height 22.6m

Installation area: 8,997.38m^2 (Reclaimed land, Tokyo)

Building area: 2,988.38m^2 Total floor area : 7,330.28m^2

Line of business: (Industrial wastes) plastic wastes, waste paper, wooden waste, fibers waste, rubber wastes, scraps, wastes of glass, concrete, and ceramics, slag, rubble (including industrial wastes containing mercury)

(General wastes) Wooden wastes, lunch wastes, wastes occurring during change of abode

2. Recycling System Flow

A “High-precision Screening Recycling System” was established, which consists of about 270 units of equipment. This system incorporates the technology of screening mixed construction wastes mechanically and automatically (achieving enhanced screening capacity) and the technology to facilitate easy recycling of screen wastes (achieving increased quality accuracy).

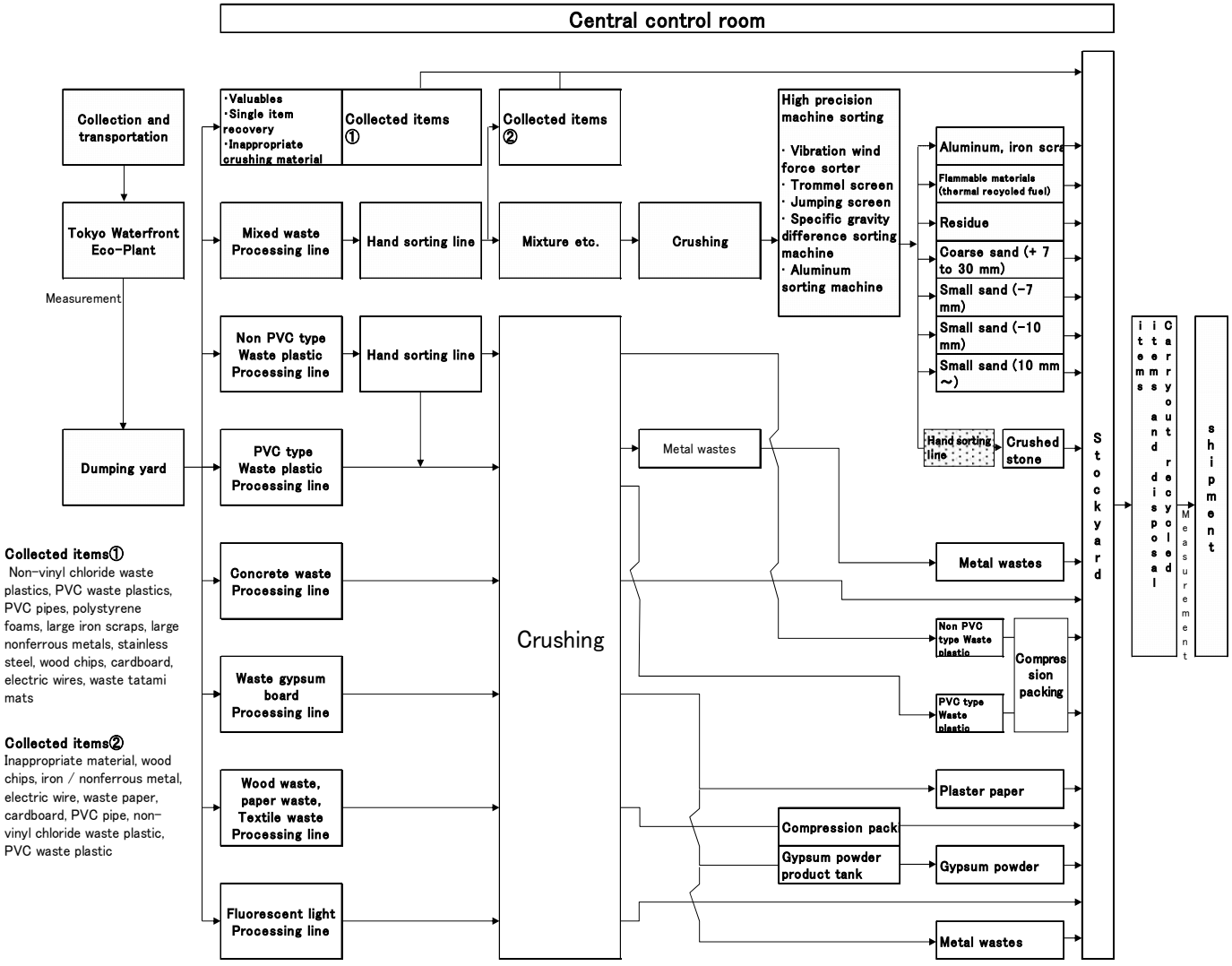


Figure 1 System flow of "High precision sorted recycling system"

3. High-precision screening with the mixed construction wastes treatment line

The throughput of the mixed wastes treatment line shown in Fig. 1 is 1,470t/day. (The throughput of the facility as a whole is 2,784t/day.)

This line is featured in that fine wastes (called “minus sieve residue”) left after primary treatment are screened. This is not normally done in other intermediate treatment facilities. High-precision recycling is enabled by screening such minus sieve residue in several stages using various machines including the non-combustibles cleaner, nonferrous screener, color screener, near-infrared material screener, screener by difference in specific gravity, jumping screen

4. Recycled products after high-precision screening

High-precision screening of mixed wastes treatment line screens out recycled crusher-run, recycled sand, combustibles (mixture of plastics wastes, wastepaper, and waste woods), iron, aluminum, and non-ferrous metals. Recovered dusts and fine dusts are pelletized by a kneading machine and used currently as cement raw materials.

Recycled crusher-run and recycled sand are used as materials for temporary construction in the construction site while combustibles are used as raw materials for cement raw fuels, solid fuels, and raw fuels for thermal recycle facilities.

From this line, there is almost no wastes to be disposed of by landfill.

Photo 2 Recycled products from mixed waste s

5. Development of the technology for screening by color, which is to recover high-quality recycled crusher-run from mixed construction wastes

After mechanical screening, recycled crusher-run contains about 10 – 15% of glass, bricks, rigid plastics, non-ferrous metals, etc. that are similar in specific gravity. New technology was developed to identify glasses, bricks, rigid plastics, etc. by referring to minute color difference among them. For this purpose, the color screener appropriate for screening construction wastes, which have been developed in coordination with the dedicated color screener manufacturer, was combined with the non-ferrous metal screener.

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

Affiliation	Research group for “Neko Chip” construction method	
Location	within Fatech Corporation 2-2 Tsukugadocho Shinjuku-ku, Tokyo,162-8557,Japan	
Position:		
Name/Surname		
e-mail		
Title	**“Neko Chip” construction method**	
Theme classification		Prevention
	○	Re-use
		Recycle
		Reduce Co2
		Legacy
		Business to overseas
		Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020
Specific content	-According to the Geofiber Method, the growth base is sprayed over the slope surface by a special machine. Such growth base is created by mixing wood chips (branches and leaves; root stocks) obtained locally with locally generated soil (including surface soil). -Deforestation trees are used after primary crushing into raw chips. -Since the growth base can be created in large quantity by means of the high-speed belt conveyor type sprayer and the pump feed method, the cost can be reduced.	
Appeal point	-Since the growth base of surface soil, including excavated soil, contains mixture of the local plant seeds, microorganisms, etc. This is advantageous for sprouting and growth of indigenous plants, which in turn causes rapid transition to indigenous plants and preservation of biodiversity.	

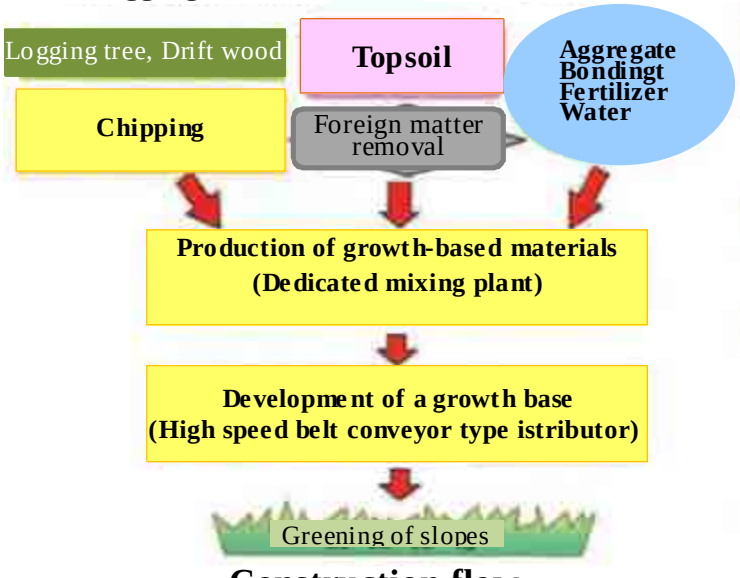
Geofiber Method

1. Outline

Wood chips obtained by crushing felled trees into needle shape are mixed with locally generated soil. The mixture is then sprayed over the slope by a high-speed belt conveyor. In this way, this greening method enables restoration of existing vegetation and recycling. Wooden chips as large as about 15 cm can be used in the green state. Locally generated soil mixed with the topsoil becomes the soil appropriate for vegetation, contributing greatly to restoration of existing vegetation and to creation of growth base that is stable and not deteriorated over a long time of period.

Logging tree

Chip material



Construction flow

Development of a growth base

Sprinkling on the side of the growth base material

2. Features

- Restoration of existing vegetation, diversification of vegetation, and conservation of the eco-system through utilization of locally generated topsoil
- Creation of the long-term stable growth base through use of soil mainly of inorganic elements
- Suppression of the generated amount of construction wastes and cost reduction through recycling
- Use of large green wooden ships to create the growth base. In addition, the top soil, roots contained in topsoil, soil with high clay content, etc. can also be used effectively.
- Efficient and economic work by means of a mechanical system using a dedicated plant and high-speed belt conveyor

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

Affiliation	Tokyo Urban Planning and Development Corporation	
Location	Central Breakwater Inside landfill,3 Aoumi, Koto-ku Tokyo	
Position:	Manager Administration Section ,Construction Waste Soil Recycling Center	
Name/Surname	AKIRA AMATSU	
e-mail	amatu01@toshizukuri.or.jp	
Title	**Tokyo Metropolitan Construction Waste Soil (Excavated soil) Recycling Center Operation Management Project**	
Theme classification		Prevention
	○	Re-use
		Recycle
		Reduce Co2
		Legacy
		Business to overseas
		Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020
Specific content	- This center operates three functions of the information management center, stockyard, and soil improvement plant in an integrated manner in order to effectively promote the reuse of excavated soil generated from public works in Tokyo. Stockyard: Stock capacity: 90,000 m3, Stock area: 2 ha Soil Improvement Plant: Maximum 150 t/h x 2units Annual soil production volume of Approximately 300,000 m3	
Appeal point	- This center is the world's first site to integrally operate and manage the functions of a stockyard, soil improvement plant, and information management center of excavated soil.	

Earth-friendly Facility

Tokyo Metropolitan Construction Waste Soil (Excavated Soil) Recycling Center

Tokyo Urban Planning and Development Corporation

Recycling of Soil Generated by Construction

Tokyo Metropolitan Government's Policy for Construction-generated Soil

The Tokyo Metropolitan Government implements measures on soil generated by construction according to five (5) basic principles:

(1) Soil quantity
(2) Control of soil quantity
(3) Promoting recycling

As a way of concretely implementing the above principles, the Tokyo Government established the Tokyo Metropolitan Construction Waste Soil Recycling Center in May 1992.

(4) Securing the entities/places that would accept the soil
(5) Promoting the appropriate soil improvement

This Center has three functions: as an information center, as a stock yard, and as a soil improvement plant. To effectively recycle the soil generated at public works Sites in Tokyo, these functions are integrally utilized. This Center is under the Bureau of Urban Development of the Tokyo Metropolitan Government and is operated/managed by the Tokyo New Town Development Corporation.

Outline of the Tokyo Metropolitan Construction Waste Soil Recycling Center

[Address] Chuo-bohatei-uchigawa-umetatechinai, Chisaki, 3-chome, Aomi, Koto-ku, Tokyo

[Purpose] Reducing the quantity of disposable waste soil generated by public works in Tokyo, while reducing the quantity of mountain sand to be collected, thus, contributing to the creation of a sound recycling society through the recycling of construction-generated soil

[Service Details]
1. Accepting construction-generated waste soil and providing regular soil
2. Raising the quality of construction-generated waste soil and providing improved soil
3. Research on soil quality

Administration Center

Administration Center
Based on information from the Tokyo Government, it operates the stock yard and the soil improvement plant, controls soil quantity, as well as coordinates the integral functions of the Recycling Center, such as central monitoring devices, soil laboratory, etc. It also serves as a reception for ticketing and similar jobs.

Stock Yard
It serves as a storage facility wherein regular soil is temporarily placed, a temporary soil storage facility before treatment at the plant (Soil for Treatment Yard), a drying facility for treating soil (Stock Yard A and B), and a storage for improved soil (Improved Soil Yard).

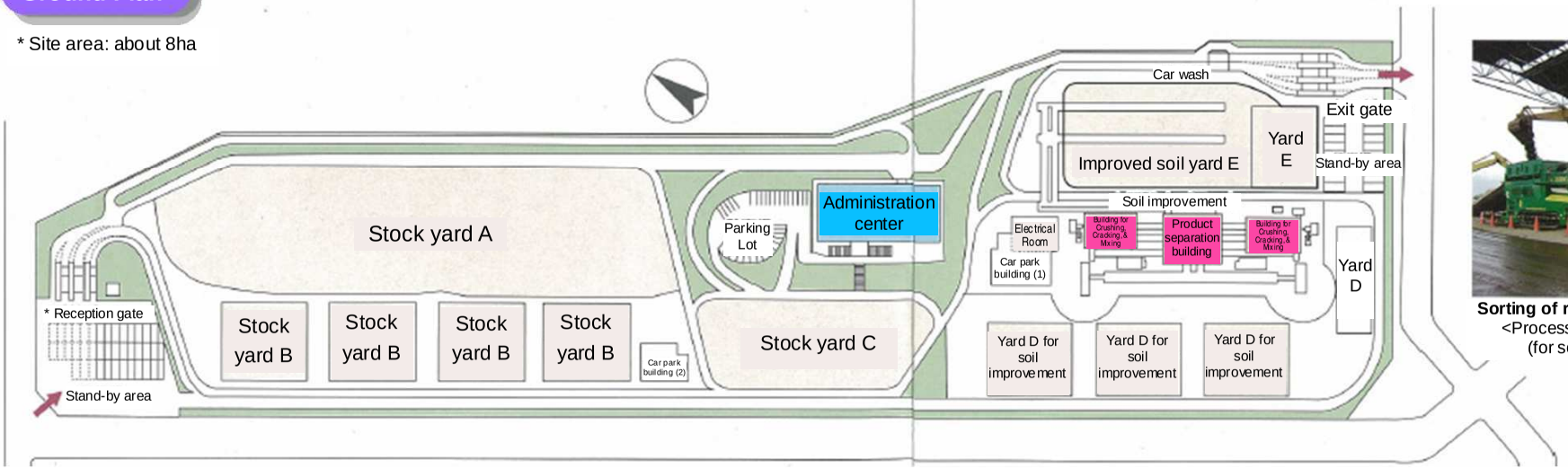
Soil Improvement
Here, they adjust the sizes of grains of clay of waste soil which cannot be recycled as it is, then mix soil with unslaked lime to improve its quality to the same level as that of mountain sand.

Stock Yard A and B
<Temporary stock capacity: 90,000m^3, Area: 2h>

Soil Improvement Plant
<Processing capacity: 150t/h (2 units), Annual output:300,000m^3>

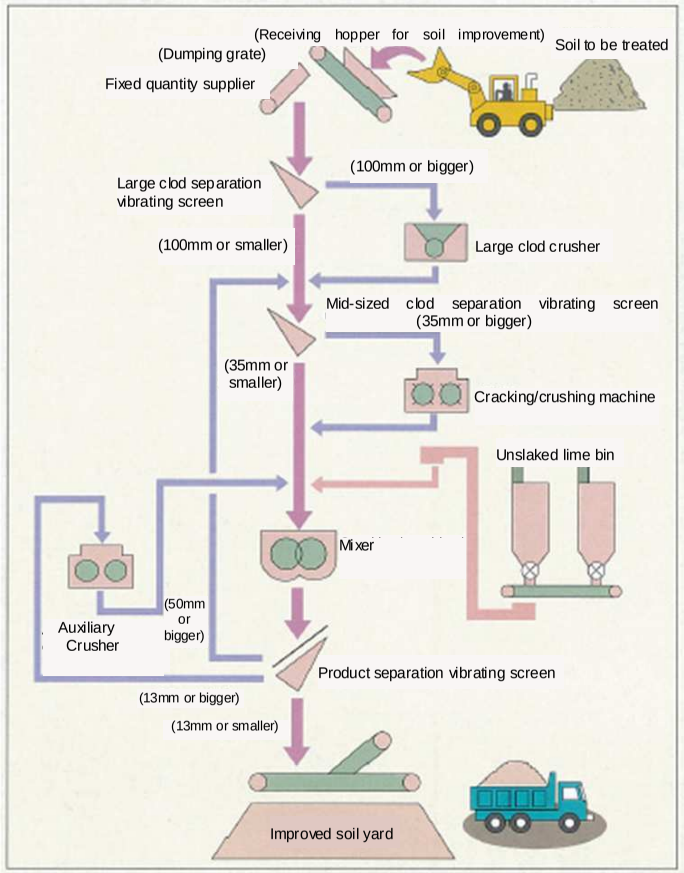
Ground Plan

* Site area: about 8ha



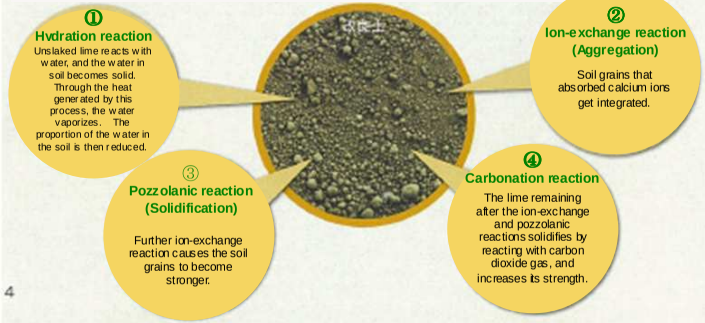
Sorting of received soil by using a trommel
<Processing capacity: about 400m^3/day (for soil received by the Center)>

● Soil Improvement System Using Unslaked Lime



● Chemical Reaction and Effects of Mixing with Unslaked Lime

Waste soil from construction sites, mixed with unslaked lime using a cracking/crushing/mixing machine, causes the following four chemical reactions, which then changes into dry soil that is strong against pressure and difficult to crumble, thus being recycled as improved soil.



● Quality Standards of Improved Soil

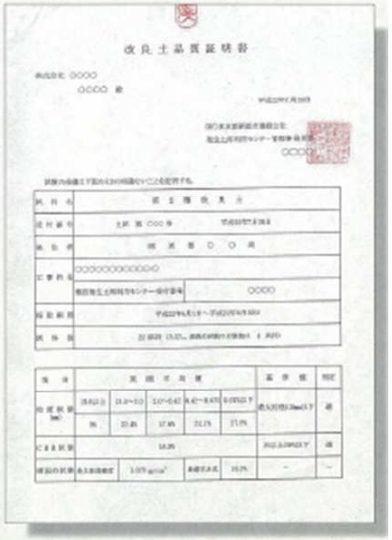
The quality of the improved soil satisfies the standards of Type 2 Improved Soil stipulated by the Construction Guidelines on Road Occupancy in Tokyo Metropolitan.

1. Grain diameter: 13mm or less
2. CBR: 3% or more, 20% or less
   (Each value of the quality control data tested 30 days before the shipment shall be 3% or more, and the mean value shall be 20% or less.)

▾ Soil Quality Testing Laboratory ▾

● Quality Certificate of Improved Soil

A certificate is issued upon request.



▾ Supervisory Control Room (for monitoring the soil improvement process) ▾

1. Service Days & Related Information

(1) Sending out of improved soil / receiving of waste soil

	Daytime	Nighttime
Days open	Monday - Saturday	
Days closed	Sundays, holidays (including substitute holidays), August 12 - 16, December 28 - January 4, and other days specially designated)	
Service hours	8:30 - 17:00	22:00 - 5:00

(2) Processing of applications and issuance of tickets to use the facility

Days and Time	Monday - Friday, 9:00 - 17:00
Days closed	Saturdays, Sundays, holidays (including substitute holidays), August 12 - 16, December 28 - January 4, and other days specially designated)

2. Construction Applicability and Criteria for Acceptance

(1) Construction Applicability

Tokyo Government-related public works, located within the radius of 30km from the Recycling Center (In principle, the construction shall require bringing in the waste soil and taking out either ordinary soil or Type 2 improved soil.)

(2) Acceptance Criteria

Acceptable Soil Type	Soil Classification
Fine sand, sandy soil, silt and cohesive soil	**Type 1 Construction Waste Soil** **Type 2 Construction Waste Soil** **Type 3 Construction Waste Soil**
Kanto loam	**Type 3 Construction Waste Soil** **Type 4 Construction Waste Soil**

1. Soil that does not contain toxic substances (According to the criteria, the “Certificate of Soil Test on Toxic Substances” or the “Soil Test Report” shall be required when submitting the application.)
2. Waste containing waste wood, asphalt, concrete blocks, metal, debris, etc. shall not be accepted.
3. Acceptable types of soil and classifications shall be according to the table on the left.
4. The soil shall not be of high water content and shall not discharge odor.
5. Soil from the construction sites of the areas designated by the Soil Contamination Countermeasures Act and the Act on Special Measures for the Prevention of Dioxin, etc. must not be accepted. (Please refer to the website of the Bureau of Environment, Tokyo Metropolitan Government.)

* For details of the acceptance criteria, please refer to the Guidelines on the Use of the Center.

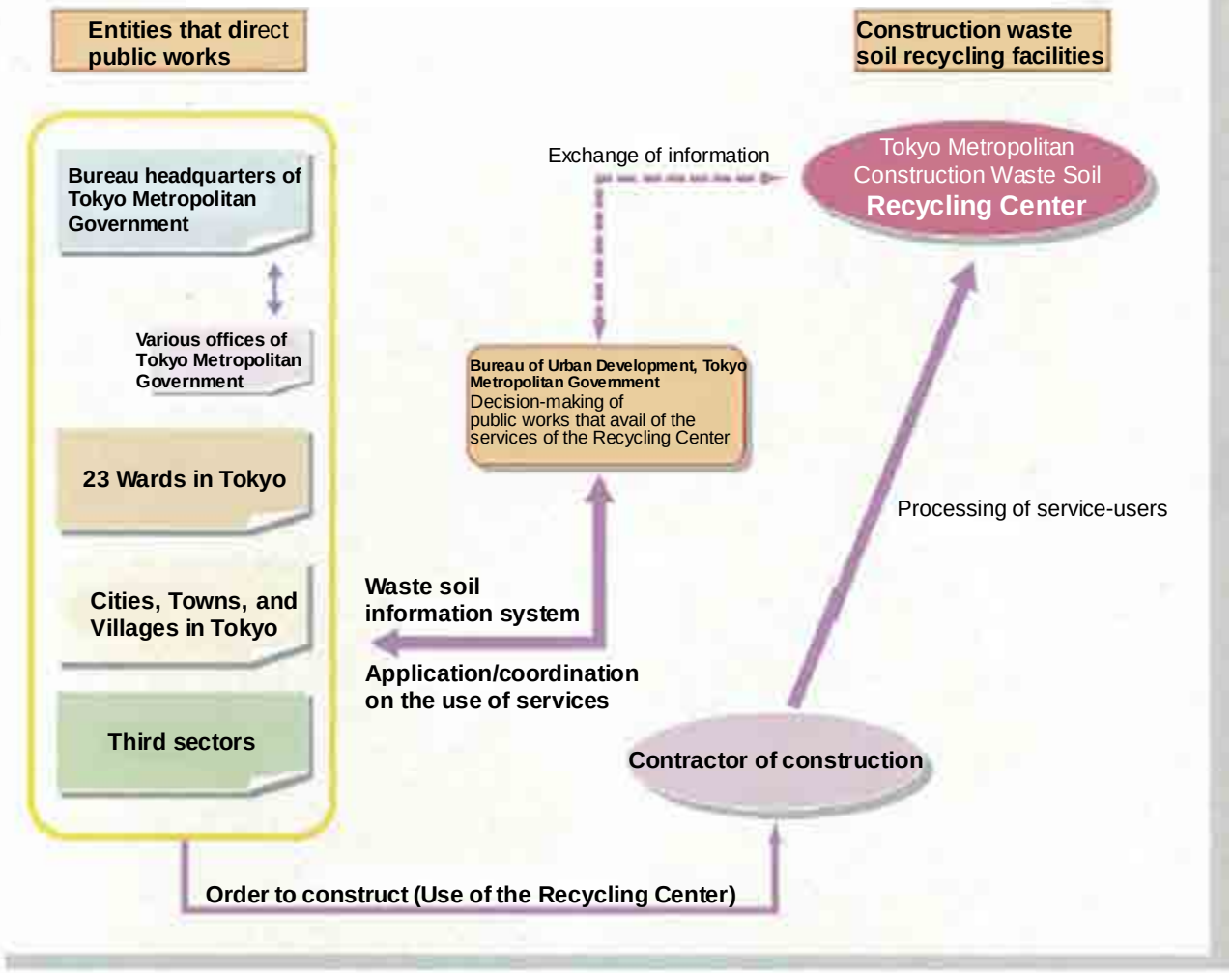
Weighing at the entrance gate

The quantity of soil to be carried in and out is measured and recorded by truck scales upon arrival and departure.

In the Recycling Center, we endeavored to prevent overloading by issuing the Manual on the **Prevention of Overloading**, as well as to promote accident prevention and a safe transport.

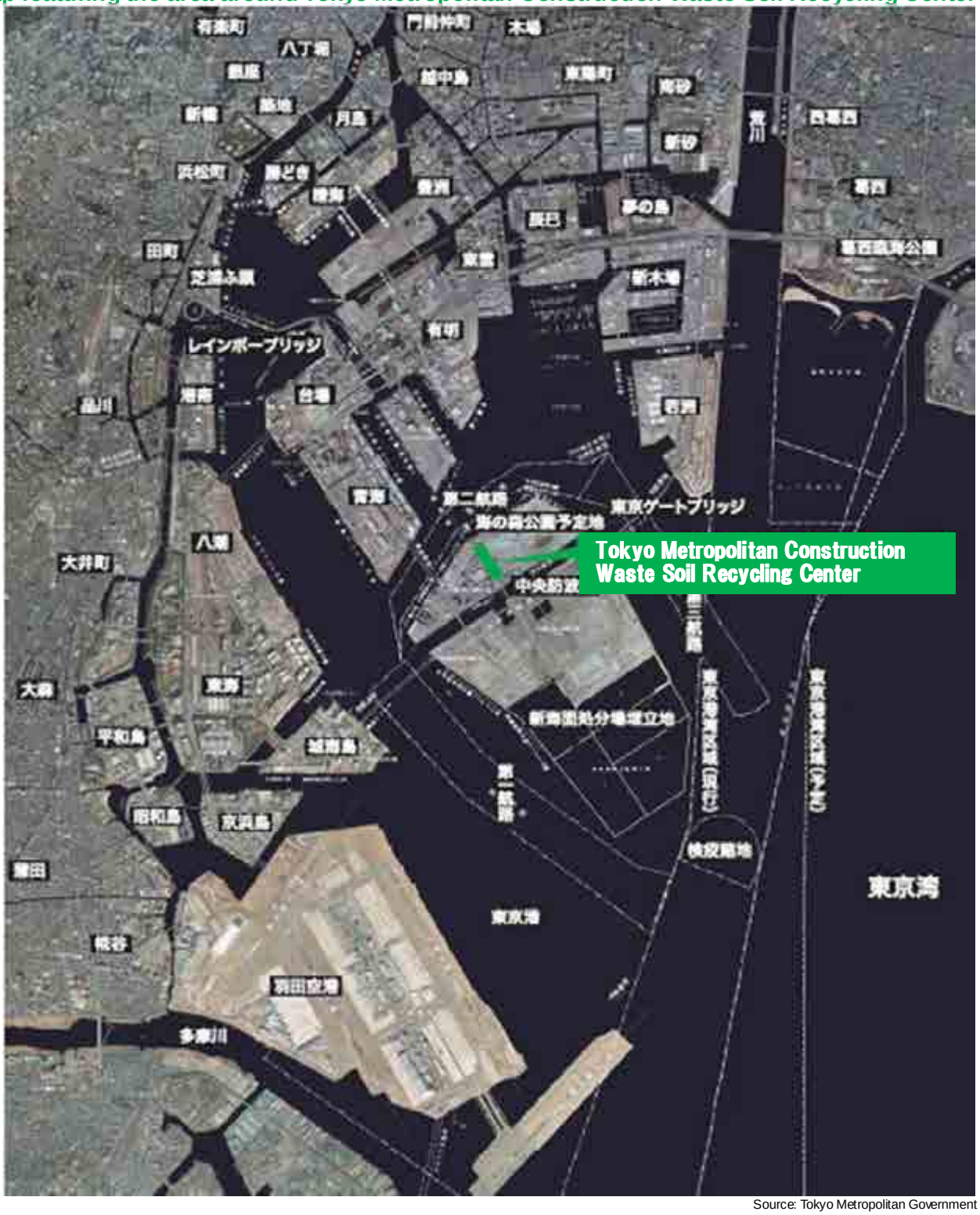
Exit gate

Construction Waste Soil Recycling System



View of the entire yard for soil improvement

Map featuring the area around Tokyo Metropolitan Construction Waste Soil Recycling Center



Source: Tokyo Metropolitan Government

Tokyo Urban Planning and Development Corporation

4-7-1 Koyasu-machi, Hachioji City, Tokyo 192-0904 Tel: 042-686-1613
URL:http://www.toshizukuri.or.jp/

Tokyo Metropolitan Construction Waste Soil Recycling Center

Chuo-bohatei-uchigawa-umetatechinai, Chisaki, 3-chome, Aomi, Koto-ku, Tokyo 135-0065
Tel: 03-3520-0982 Fax: 03-3520-0827

This brochure is made of 100% recycled paper.

Prepared on August 2017

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

Affiliation	Tokyo Outer Ring Road Office, Kanto Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Tokyo, Japan	
Location	TE Bldg. 7F, 5-5-10 Yoga, Setagaya-ku, Tokyo 158-8580 Japan	
Position:		
Name/Surname		
e-mail		
Title	**Policy on excavated soil generated Tokyo Outer Ring Road (Kanetsu～Tomei) construction**	
Theme classification		Prevention
	○	Re-use
		Recycle
		Reduce Co2
		Legacy
		Business to overseas
		Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020
Specific content	- The Tokyo Outer Ring Road Tunnel Excavated Soil Conference chaired by Honorary Professor Kamon of Kyoto University developed a “Manual to Manage Soil Excavated during Tokyo Outer Ring Tunneling,” summarizing the policies for management of shield excavated soil. And, we plan to make effective use of shield tunnel generated soil of about 20,000 m 3 per day.	
Appeal point	- Shield tunnel generated soil from the muddy pressure shield construction method has been often handled as construction sludge (industrial waste) in many cases. -In this project, by devise shield excavation method and additives etc. taking advantage of the characteristics of the hard drilling strata distributed in the deep underground, we effectively utilize shielded tunnel generated soil as excavated soil for embankment material etc.	

Policy on excavated soil generated Tokyo Outer Ring Road (Kanetsu～Tomei) construction.

Yoshio SHIBATA[1], Kenji KATO[2] , and Junichi SUGII[3]

[1] General Manager; Tokyo Outer Ring Road Office, Kanto Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Tokyo, Japan
[2]General Manager; Tokyo Gaikan Construction Office, Kanto Regional Head Branch, East Nippon Expressway Company Limited Tokyo, Japan
[3]Director; Tokyo Construction Office, Tokyo Branch, Central Nippon Expressway Company Limited, Tokyo, Japan

ABSTRACT: This paper addresses the policy on excavated soil generated Tokyo Outer Ring Road (Kanetsu～Tomei)construction by shield tunneling. From Tokyo Outer Ring Road (Kanetsu～Tomei) construction site, a maximum of 20,000 m 3 of excavated soil per day is generated at maximum.so it is necessary to consider proper management of such a huge amount of soils .

1. INTRODUCTION

Three metropolitan ring roads play vital role as a social capital to support economic activities and daily life of Tokyo, a heart of Japan, while contributing to mitigation of chronic traffic congestion and to environmental improvement of central Tokyo.

One of these ring roads, Tokyo Outer Ring Road, has the length of about 85 km, connecting, like a loop, the areas at about 15 km from central Tokyo. For the dedicated motorway portion (the expressway), the section of about 49 km has been opened for service up to now, which runs from the Oizumi Junction connecting to Kanetsu Expressway and the Takaya Interchange connecting to Higashi Kanto Expressway.

For the section of about 16 km (or the Tokyo Outer Ring) from Kanetsu Expressway to Tomei Expressway, Ministry of Land, Infrastructure, Transport and Tourism (MLIT), East Nippon Expressway Company Limited, and Central Nippon Expressway Company Limited are jointly undertaking the project.

Fig. 1 Outlines of the metropolitan area three-ring road

2. ROAD CONSTRUCTION

The Section runs mostly through the deep underground tunnel structure, the greatest shield tunnel of Japan with three lanes each way, having the diameter of about 16 m.

Fig. 2 Outline of the plan of the Tokyo Outer Ring (Kanetsu ~ Tomei)

Photo.1 Shielded machine with a diameter of about 16 m

3. POLICY ON EXCAVATED SOIL GENERATED SHIELD TUNNEL CONSTRUCTION

A total of four 16-m diameter shield machines were employed for tunnel excavation; two northbound and two southbound respectively from the Oizumi Shaft and the Tomei Shaft. These shield machines produced excavated soil of maximum about 20,000 m^3 daily.

Since large amount of soil generated within short periods is to be removed, as needed, to the outside of the work site, the Tokyo Outer Ring Road Tunnel Excavated Soil Conference chaired by Honorary Professor Kamon of Kyoto University developed a "Manual to Manage Soil Excavated during Tokyo Outer Ring Tunneling," summarizing the policies for management of shield excavated soil.

This manual summarizes the flow of handling and management of shield excavated soil, temporary storage method, judgement method, transportation control, the concept of additives mixing, etc. The manual describes the policies for effective and efficient utilization of shield excavated soil for other projects outside the work site.

For soil excavated with mud slurry shield, the project is intended basically for effective utilization of such soil for embankment, etc. as soil generated from construction, by exploiting merits of hard excavation formation distributed in the deep underground and by improving the shield method and additives. In order to enable effective utilization of large amount of construction byproducts as invaluable resources, efforts are done to achieve the objective through promotion of discussions with various receiving parties while referring to this manual.

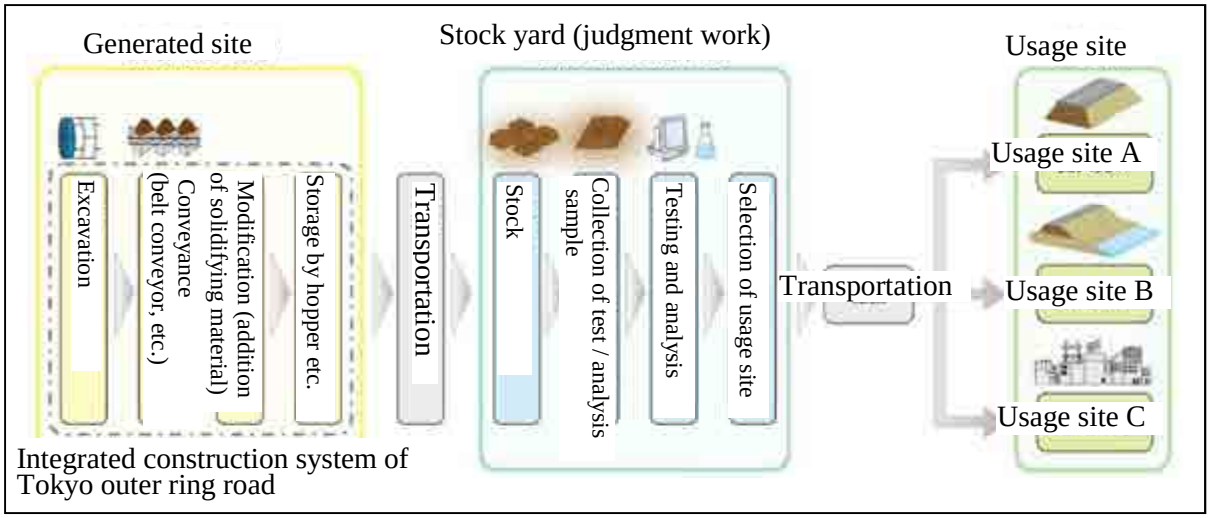


Fig. 3 Flow of management of shield generated soil

Excerpt from "Manual to Manage Soil Excavated during Tokyo Outer Ring Tunneling,"

4. CONCLUSIONS

Transport of shield excavated soil and transport of materials and equipment of other projects are expected to cause congestion. Besides, it is important to ensure traceability of shield excavated soil from the source of generation to the destination. In this context, the transport management is currently under consideration. The Tokyo Outer Ring Road is a project requiring highly-developed technical power mainly on underground structures. With the aim of making this project a model in large cities, we will proceed with the project with cooperation extended from authorities concerned, experts, and local residents while paying due attention on the safety and surrounding environment.

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

Affiliation	MORI Forest Environmental Technology Laboratory Co. ,Ltd	
Location	7-6 odajima-cho,shinjo-city , yamagata Pref. 996-0071 Japan	
Position:	CEO	
Name/Surname	MASATO MORI	
e-mail	e-mail:info@mori-kankyo.co.jp	
Title	**Bon Terrain Construction Method (High moisture content mudbank recycling system)**	
Theme classification	○	Prevention
		Re-use
	○	Recycle
		Reduce Co2
		Legacy
		Business to overseas
		Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020
Specific content	-Professor Hiroshi Takahashi of Graduate School, Tohoku University and the MORI Forest Environmental Technology Laboratory Co. ,Ltd have jointly developed the Bon Terrain process. This process provides additional characteristics, such as superior strength, superior earthquake resistance, superior durability, and others, to bottom deposits of dam pond by loading and mixing the fibrous deposits improvement material, “Bon Fiber”, together with fixation agent. -Banking of rivers and dam ponds, to which this process had been applied before the Great East-Japan Earthquake occurred, developed no crack and liquefaction damage the Earthquake actually occurred.	
Appeal point	**-Contribution to recovery and reconstruction in the site of large-scale sedimentation disasters that have occurred frequently** This process enables recycling of deposits left after tsunami as raw materials into highly-functional ground materials, contributing thereby to rapid restoration from disaster. This environmentally-conscious process enables recycling of various organic deposits in the original locations while offering substantially favorable impacts on the society. Our efforts to promote “Monozukuri (manufacturing)” through cooperation among academic, industrial, and governmental circles has been highly evaluated and awarded the 6th Monodukuri Japan Prize in 2015. This technology is expected to offer extremely high propagation effects through significant contribution to the reconstruction and restoration of large-scale sedimentation disasters that are probable in the future. Contribution to strengthening of the national land is also expected. **-Efforts to support overseas development of the new technologies** Major 2011 flooding of the Chao Phraya River in Thailand has caused continuing flood disaster for more than a month. Professor Hiroshi Takahashi, Graduate School of Tohoku University, the associate developer of this process, and the staff of Advanced Construction Technology Center visited Kasetsart University, King Mongku’s University ,Pak Kred city in the neighborhood of Capital Bangkok. There, they outlined the technology and performed publicly the laboratory experiment using Thailand clay. At suggestions of the Pak Kred municipal staff, this process was named Soil Dike Super Fiber Method”to facilitate easy understanding of technology by the Thai engineers. We expect that our “Monodukuri Technology” will contribute to assistance and aid for reconstruction overseas in the future.	

NETIS registration No. TH-020042-V

High moisture content mudbank recycling system

Bon Terrain Construction Method

Bon Good **Terrain** Soil

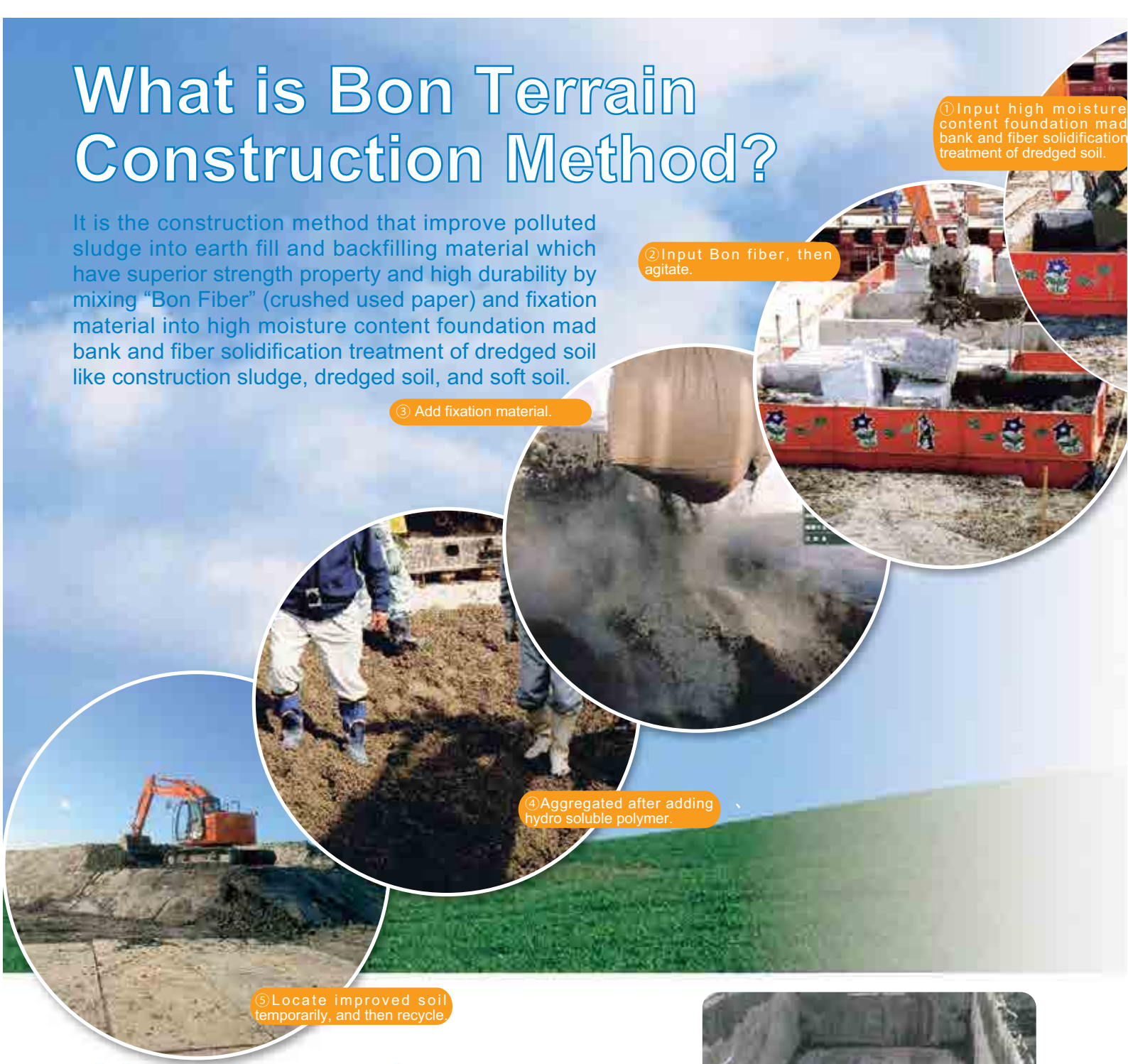
Recycling all the "Construction polluted sludge", "Dredge soil", and "Soft soil" without dehydration with using used paper

Certified by Advanced Construction Technology Center
No.1703 Dec. 2005

Bon Terrain Committee

What is Bon Terrain Construction Method?

It is the construction method that improve polluted sludge into earth fill and backfilling material which have superior strength property and high durability by mixing “Bon Fiber” (crushed used paper) and fixation material into high moisture content foundation mad bank and fiber solidification treatment of dredged soil like construction sludge, dredged soil, and soft soil.

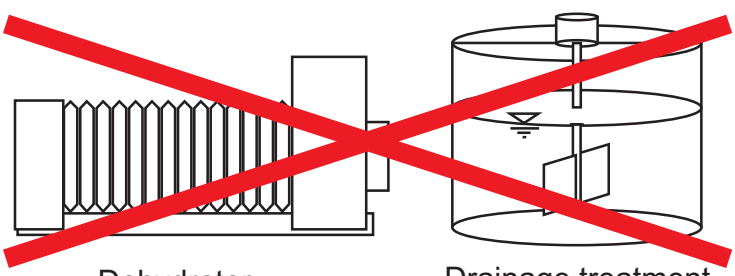


You do not have to install dewatering process and drainage treatment equipment.

■It is possible to improve 500% of moisture content like high moisture content foundation mad bank and fiber solidification treatment of dredged soil which needed dewatering process.

■It is possible to improve the soil with keeping high moisture content foundation mad bank and fiber solidification treatment of dredged soil’ s water content. And it does not need to drain away.

■You do not have to install dewatering process and drainage treatment equipment.



Dehydrater

Drainage treatment equipment

The chance has come for an environment business.

●This construction method obtained “Construction technology screening certification” from Advanced Construction Technology Center.

●This construction method was awarded “Construction engineering award” from Japan Institute of Construction Engineering.

●This construction method was awarded “Minister of land, infrastructure and transportation award” at “The 6th person of merit for industry-academic-government combination implementation citation” which was hosted by Cabinet office, the ministry of Internal affairs and communications, ministry of education, culture, sports, science and technology, and ministry of economy, trade and industry.

The feature of Bon Terrain construction method

■It is possible to transport high moisture content foundation mad bank and fiber solidification treatment of dredged soil (500 of moisture content) promptly just after improvement by adding and mixing hydro soluble polymer.

■All you have to do is install attachment for agitating into backhoe without special equipment.

■Construction will be done in 30minutes for 1 cycle.

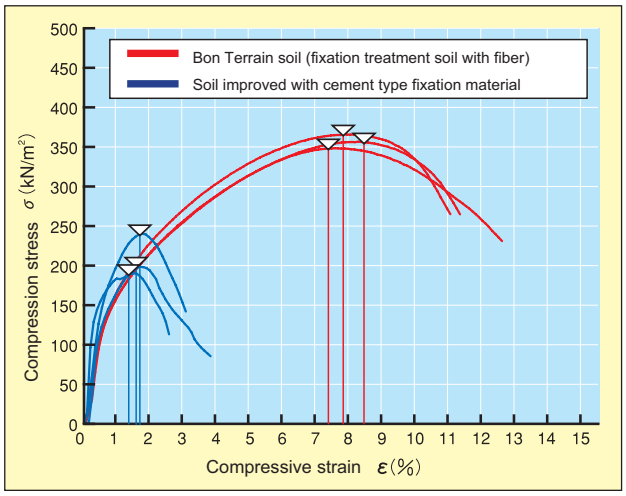
■Bon fiber and hydro soluble polymer are produced in proper production process and are safe products.

Construction name: Urban area water space upgrading project　Land creation of Haga pond area / Outline : Improving storage reservor soil with Bon Terrain and recycling as banking material of Shinsui park

Superior strength character

It is useful to use Bon Terrain as ground material for the earthquake countermeasures which is persistent to changing in shape because it is bigger uniaxial compression strength and breaking strain compared with solidification treatment soil.

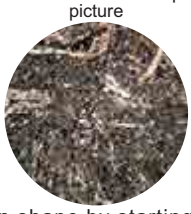
Superior strength character



Add 100kg/m of cement type fixation material into 150% of moisture content soil （σ28）

Bon Terrain soil

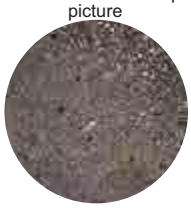
Polarization microscope picture



Bon terrain soil holds against changing in shape by starting barreled change, and deploying of stress through fiber.

Solidification treatment soil

Polarization microscope picture



Obvious shear plane comes out, and fixation soil starts local deformation concentration. After that, it will be broken by small strain.

Big breaking strain
Small deformation coefficient

Persistent property

The material for the earthquake countermeasures

According to repeating triaxial compression exam, it was found that Bon Terrain soil has high dynamic strength. It means that it is hard to be liquefiable compared with solidification treatment soil because Bon Terrain hardly increase express pore pressure.

Backfilled manhole with mountain sand was raised by liquefaction by earthquake

Shaft and backfilling of open-cut part by Bon Terrain soil
The year 1999 Suka River public sewer west rainwater arterial , the 3rd construction

Bund breaking by North Miyagi earthquake (Naruse River, Miyagi pref.)

Bon Terrain reform of soft soil deposited on anti-flood pond. Recycling as bund earth fill material
The year 1999 Hamao area embankment construction

Highly durable reformed soil

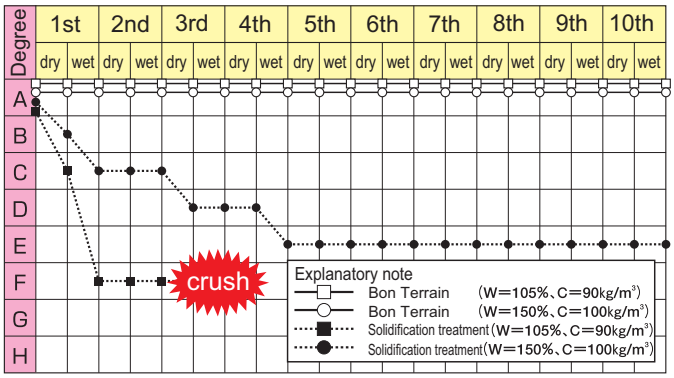
It is useful to use Bon Terrain reformed soil as the highly durable ground material because it has high durability to wet-dry repeating by climate condition and freezing and thawing.

Wet-dry repeating test

According to repeating wet dry test, we found that the test piece of solidification treatment soil is crushed by cracking. However, Bon Terrain showed that it has high durability.

Degree of Soundness

Degree	Cracking	Lack
A	Outwardly mostly no change	
B	Tiny and local cracking	Local Surface delamination
C	Partly obvious cracking	Missing part of the test piece
D	Entirely obvious cracking	Bigger cracking of the test piece
E	Partly or wholly falling of test piece	
F	Totally falling and crashing of test piece, but it remains	
G	Totally falling and crashing of test piece, but it is massive	
H	Totally falling and crashing of test piece, but it is grain refinning and muddy	



Bon Terrain redormed soil

After 10 cycle W=105% C=90kg/m³

No change after 10th cycle

Solidification treatment soil

After 2 cycle W=105% C=90kg/m³

Wholly crushed after 2nd cycle

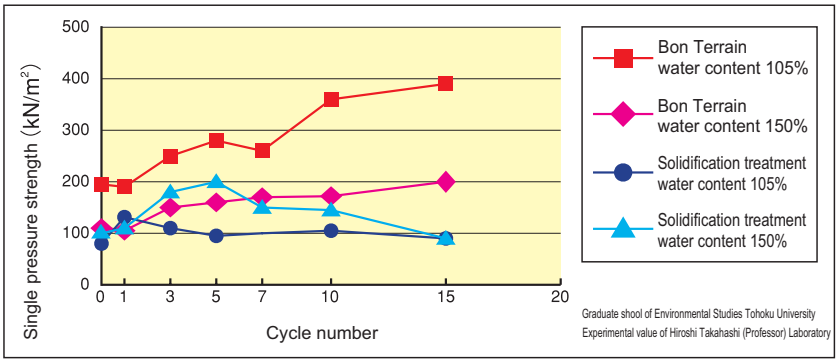
Repeating dry and wet test: It is conformed with "Advanced process of construction sludge and Development of usage technique" which the former Ministry of Works Civil engineering Research worked hand in hand with Advanced Construction technology center and 22 of private companies

Freezing and thawing test

According to the freezing and thawing test, it was found that solidification treatment soil is decreasing in uniaxial compression strength, however, Bon Terrain showed high durability without decreasing.

Testing method

- Curing for 7 days after making test piece
- Melting for 12 hours at 21℃ after freezing for 12 hours at -21℃ (1 cycle)
- Uniaxial compression test after 0,1,3,5,7,10,15 cycle



Recycling as low permeability material

Coefficient of permeability is k=10^{-5}~10^{-6}cm/s, Permeability is extremely low and it is under the level of k=10^{5} cm/s which indicates water interception that fildam core material demands. It is usefule to use this as superior bund filling because of low permeability and no cracking by repeating dry and wet test.

Example of construction

Construction name:	Ohe area regional water function implementation business (supplemental equipment and facilities business) Yakushiga pond leakage prevention construction
Promoter:	Ohe-machi, Nishimurayama-gun, Yamagata Pref.
Outline:	For the purpose of content securement, reinforcement of dam body, and leakage prevention of the storage reservoir, we improved deposited sand which into Bon Terrain soil. Then we recycled as earth fill of dam body.(Over qc=800kN/m^2 of Second class improved soil, ,under 10^{-6}cm/s of coefficient permeability)

BEFORE k=6.02×10^{-5}cm/s

Superior Workability

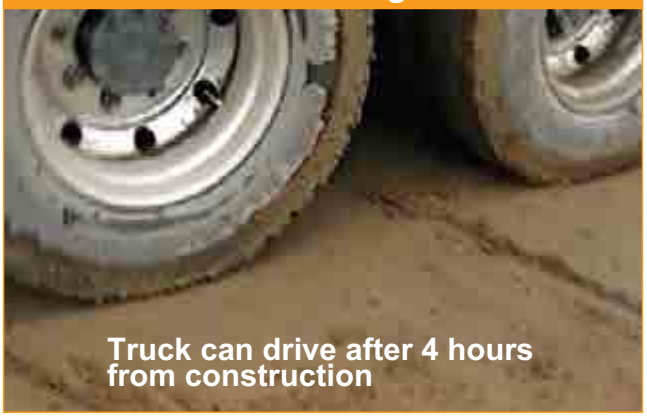
Niigata Chuetsu earthquake caused large volume of soft soil. But it was improved in-situ, and activating surface compaction. It means that this contributed to prompt disaster recovery.

① Condition of soft soil (around w=100%)

② Improving by aggitating In-situ

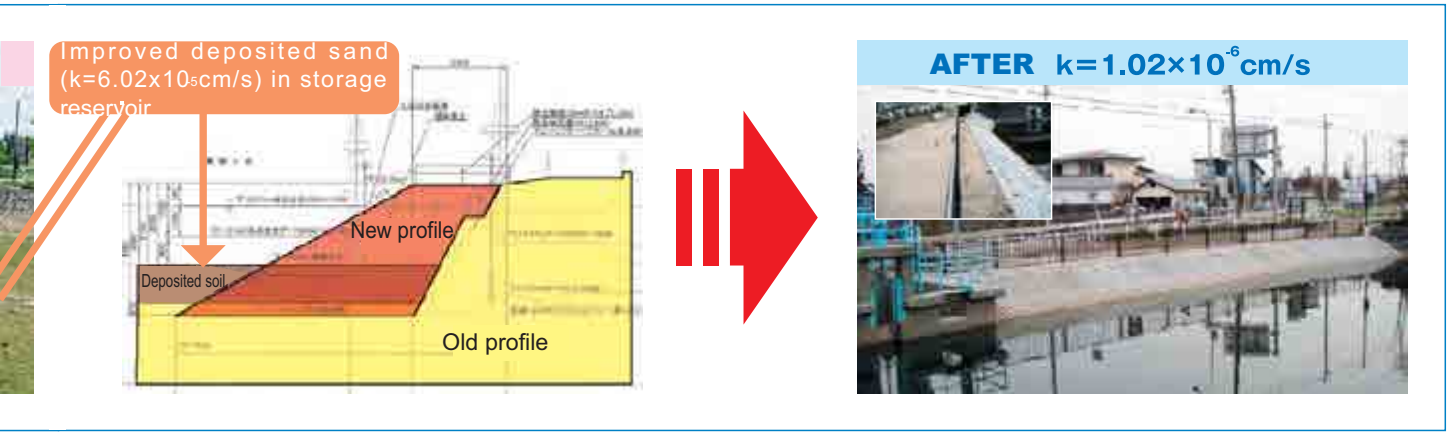
③ Forming

④ No track while driving truck



Construction name : Imogawa river channel blockade measurement construction / Promoter : Ministry of Land, Infrastructure Transport and Tourism Hokuriku regional development bureau Yuzawa Sabo office

	10^{-9}	10^{-8}	10^{-7}	10^{-6}	10^{-5}	10^{-4}	10^{-3}	10^{-2}	10^{-1}	10^{0}	10^{+1}	10^{+2}
Permeability	Factually impermeable		Exceptionally low		Low		Medium		High			
Available soil	Viscous soil		Microscopic sand, silt sand - silt - clay mixed soil				Sand and conglomerate		Clean conglomerate			



Glass prevention effect

Glass prevention effect of Bon Terrain soil reduced weeding by using for center divider and road shoulder filling. It activated reducing road maintenance cost.

Construction name : The year 1994 primary distributor Tendo-Sagae line street improvement construction
Promoter : Murayama branch, Yamagata Pref.

Keiji Masuko Chairman

Former Ministry of Works River Bureau Sand Arrestation Manager
Civil engineering manager of Fukushima Pref.

Bon Terrain construction method is recycling high moisture content mudbank to earth fill material and vegetation base material by aggregating fixation without dewatering process. Recycling construction sludge also reduces polluting load on global environment by reducing huge resource and energy consumption of industrial waste disposal. We would like to make new recycling system upgrade scholarly and technically. Thank you for your assistance and cooperation.

Marks

August, 2002	Selected by Ministry of Land, Infrastructure, Transport and Tourism Tohoku area Development Bureau Technology application committee as "The earth fill construction technology of high moisture contet soil"
August, 2002	Selected by Ministry of Land, Infrastructure, Transport and Tourism Tohoku area Development Bureau Technology application committee as "The in-plant recycling technology of construction sludge"
October, 2002	Prize-winning of Chairman from Redeuce, Reuse, Recycle Promotion Council
November, 2002	Registered for the New Technology Information System(NETIS-Ministry of Land, Insfrastructure, Transport and Tourism) Evaluated as pilot project "Bon Terrain Construction Method / TH-020042"
March, 2003	Selected by Ministry of Land, Infrastructure, Transport and Tourism Chubu area Development Bureau Technology application Committee as "Recycling technology for construction sludge from foundation pile which is constructed on site"
November, 2003	Selected by deputy minister of Land, Infrastructure, Transport and Tourism Public construction technology evaluation committee as "Recycling technology of dredge soil"
December, 2006	Certified by Advanced Construction Technology Center
July, 2007	Received a prize of "Land and Infrastructure Development Technology " from Japan Institute of Construction Technology
June, 2008	Received a prize of "Minister's prize, Ministry of Land and Infrastructure, Transport and Tourism" at "The 6th person of merit for industry-academic-government combination implementation citation" hosted by Cabinet office, the ministry of Internal affairs and communications, ministry of education, culture, sports, science and technology, and ministry of economy, trade and industry.

Scientific advisor

Akiharu Ohsaka	Emeritus (Doctor of engineering) Tokushima University
Hideo Kanari	Professor of Urban Landscape Science and technology Dept. Kokushikan Univ. (Doctor of engineering)
Hiroshi Takahashi	Professor of environmental science research, Tohoku Univ. (Doctor of engineering)
Shigeru Okada	Professor of Urban Landscape Science and technology Dept. Kokushikan Univ. (Doctor of engineering)

Technical advisor

Nobutoshi Ishibashi	(ex)Commissioner of Japan microtunnelling Association
Shigekiyo Tabata	(ex)Ministry of Works River Bureau sand arrestation manager, Head of Nara Pref. civil engineering div., Manager of Hokuriku area concstruction and river bureau
Hideki Kojima	(ex)Head of Port and Harbour Research Institute Transport Ministry, Chairman of WAVE
Kenji Nakamura	(ex)Ministry of Works Chugoku region construction bureau road division chief (ex)(Incorporated)Head director of Chugoku construction benefit association
Itaru Nakamoto	(ex)Ministry of Works, city bureau sewer dept. manager, Head of Japan Sewage Works Agency
Naotoshi Baba	(ex)Ministry of Land, Infrastructure, Transport and Tourism, Tohoku area development bureau manager, Aichi pref. construction dept manager
Tamotsu Fujimoto	(ex)Ministry of Land, Infrastructure, Transport and Tourism, Hokkaido bureau manager, Chugoku area development bureau manager, Iwate pref. civil engineering manager
Koji Hoshina	(ex)Akita pref. civil engineering manager, Akita pref. puvlic enterprise administrator
Yoshiaki Yano	(ex)Geographical Survey Institute manager, Ministry of Works Kyusyu area construction bureau manager, Oita pref. civil engineering and construction manager
Osamu Yamaguchi	(ex)Cabinet office Okinawa General Bureau manager, Shizuoka pref. civil engineering manager

Bon Terrain Committee

[Head Quarter] 7-36, Odajima-cho, Shinjo-shi, Yamagata Pref. 996-0071
TEL:+81-233-22-0832 FAX:233-22-0932
URL:http://www.vega.ne.jp/~metr/
E-mail:metr@vega.ne.jp

[West Japan Branch] 2824, Kunimaru, Iimuro, Asa-machi, Asakita-ku, Hiroshima-shi
TEL:+81-82-835-1190 FAX:82-835-2680
E-mail:bonterrain_w@festa.ocn.ne.jp

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

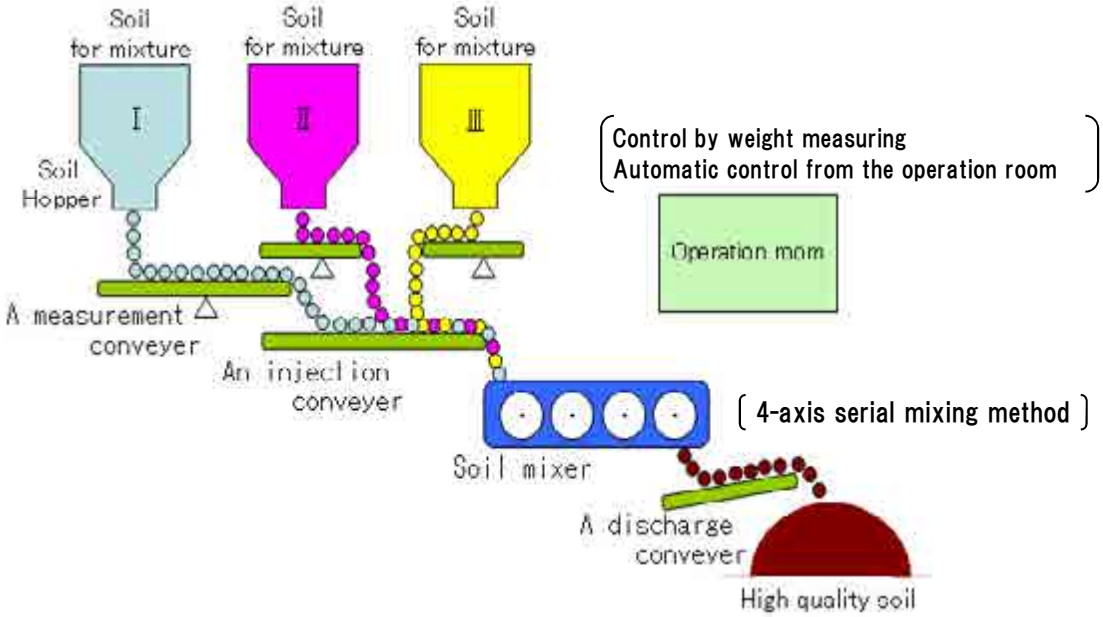
Affiliation	OKUNOKOTOH Co. ,Ltd	
Location	1-14-13,Otukacho,Takatsuki-shi,Osaka 569-0034 Japan	
Position:	Vice president	
Name/Surname	HIROZO OKUNO	
e-mail	hz.okuno@okunokotoh.jp	
Title	**OKUNOKOTOH Soil improvement technology**	
Theme classification	○	Prevention
		Re-use
	○	Recycle
		Reduce Co2
		Legacy
		Business to overseas
		Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020
Specific content	- This technology combines excavated soil of different soil properties with low-appearance excavated soil, which cannot be used as it is, and mixes them by stirring to adjust the particle size and improve the strength, thereby producing high-quality soil materials. - It is also possible to add additives at the same time, and it can be improved to the required quality soil material at low cost and according to the application to be used. Facility configuration: Sediment hopper, lightweight conveyor, input conveyor, universal soil improvement machine, discharge conveyor (solidifying material hopper) Application location: River embankment filling material Roadbed / road floor filling material, backfill material, land section building 	
Appeal point	- Recycling of low-quality excavated soil and contribution to a Sound Material-Cycle Society. - Continuous construction and productivity improvement through mechanization of soil mixing. - System technology based on computerization of mixed operation management.	

OKUNOKOTOH **Soil improvement technology**

The universal soil improving system for construction surplus soil

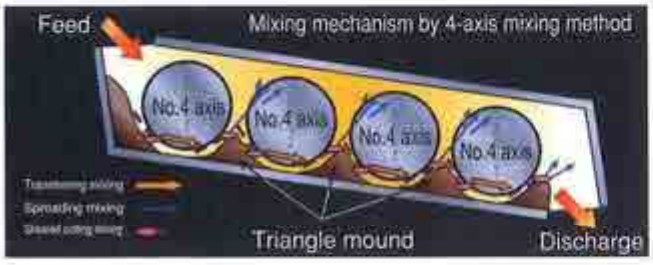
The universal soil improving system revives construction surplus soil to quality soil, by evenly stirring soil to improve grain size, as well as by adding hardening agents.
With four mixing chambers, it repeats shearing, moving, diffusing and mixing, which can accommodate various size and types of soil and clay. This system also works brilliantly for soil improvement of sludge.

System scheme



4-axis serial mixing method

- It adopts a unique structure that consists of 4 axes of the mixing blades, which are arranged perpendicular to the earth flow. It works effectively for mixing various types of soil, including clay soil, by combining deferent types of mixing methods, such as transferring, spreading, and sheared cutting.
- The special mechanism to rotate 4 axes at a higher speed one by one enables effective mixing.

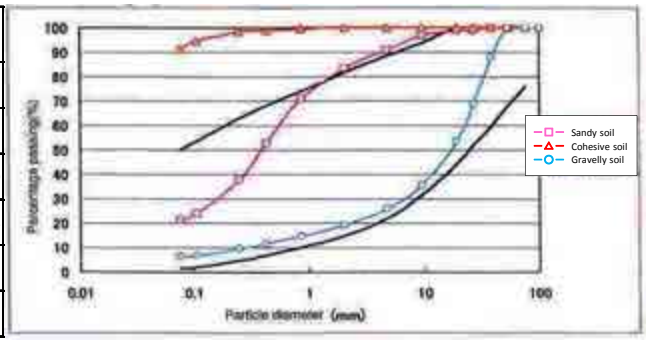


- The mixing blades arranged at random enable a continuous and stable operation, because of less pinching of foreign materials.
- The durable cemented carbide tips attached to the mixing blade reduce maintenance works, and improve the cost performance.

Construction example

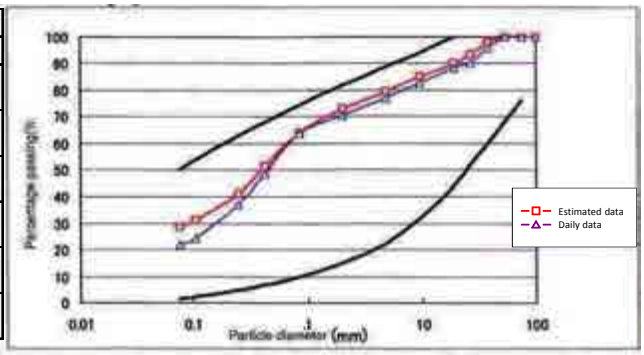
Preliminary soil test data and grain size distribution

			Sandy soil 6	Cohesive soil 2	Gravelly soil 2
Preliminary laboratory test	Water content（%）		13.5	38.2	2.2
	Classification	Gravel（%）	16.7	0.0	80.6
		Sand（%）	62.0	8.7	13.0
		Fine-fraction（%）	21.3	91.3	6.4
	Cone index (kN/m2)		5753	230	—
Soil classification			Class 1 construction-surplus soil Class	Class 4 construction-surplus soil Class	Class 1 construction-surplus soil Class



Post-mixing soil test data and grain size distribution

			Mixed soil	
			Laboratory estimated data	Daily data
laboratory test	Water content（%）		14.8	14.6
	Classification	Gravel（%）	27.2	29.6
		Sand（%）	44.3	48.3
		Fine-fraction（%）	28.5	22.1
	Cone index (kN/m2)		3277	1800
Soil classification			Class 2 construction-surplus soil Class	Class 2 construction-surplus soil Class



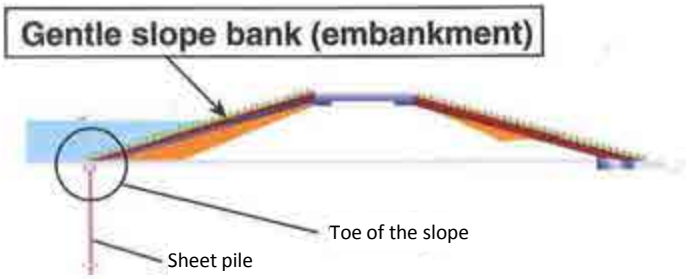
Case: Recycling of construction surplus soil into mound soil for banks

Super bank construction

Super banks may not burst even if the river-water overflows due to a serious flood; accordingly they prevent urban areas from a devastating flood.

Bank reinforcement construction

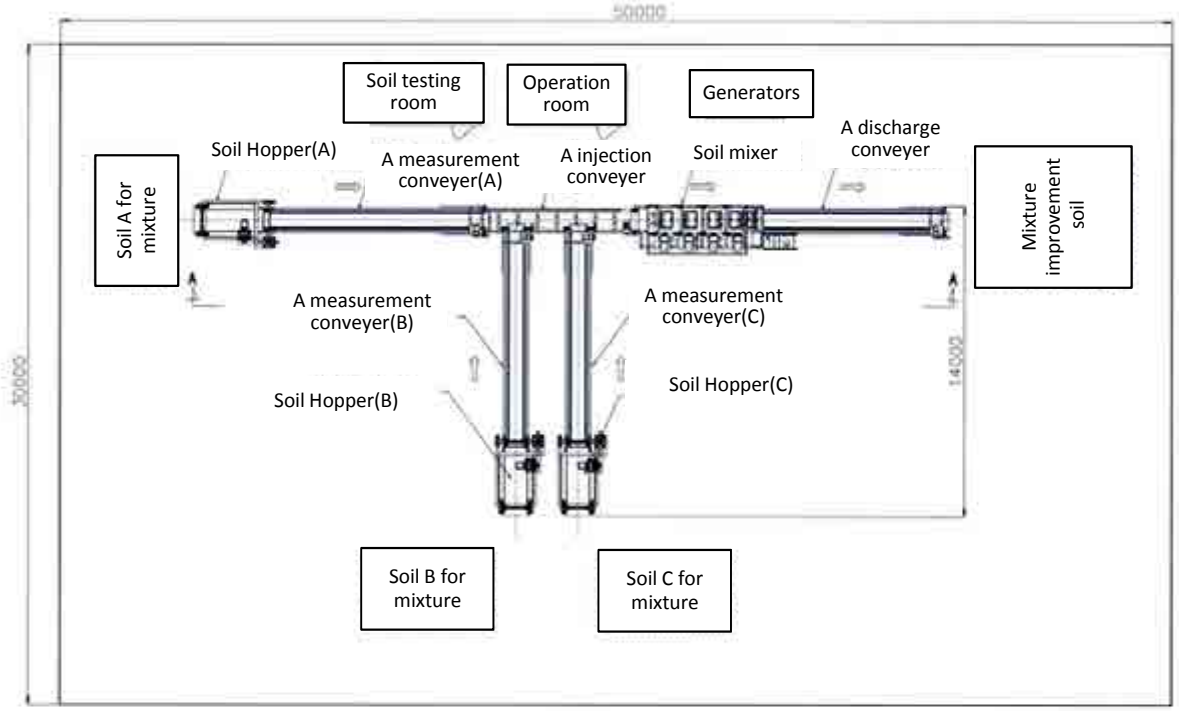
Conventional banks are built up simply by banking soil; therefore, it may burst when the bank is in a wet condition with water penetrating it, or the bank surface is scoured.
It is called bank reinforcement to strengthen the conventional bank strength ageinst bursting.



A gentle slope bank is build up by widening the bank cross-section.Increasing the bank cross-section makes a stable bank that is strong against floods. This method is used for draining quickly the water penetrated in the bank to lower the water level, by replacing soil around the toe of the slope on the river-back side (residence side) with permeable materials, such as stones.
*Toe of the slope; a point where an area protected by levee or a major bed.

Example of system setup (Case of three-kind soils)

※An arrangement is possible according to the situation of the site.



Cross-section A-A

Specification of system

Standard specification

Equipment name	Technical standard		Intended purpose
Soil Hopper ※ (With scooping-out device)	Capacity of motor: Capacity of soil hopper:	7.5kw 2㎥	Soil slot Carrying out soil measured
A measurement conveyer ※ (With measurement device)	Capacity of motor: Size of belt:	7.5kw 750㎜ width × 10m (Distance between axes)	Transporting soil measured Measuring
A injection conveyer	Capacity of motor: Size of belt:	5.5kw 750㎜ width × 7m (Distance between axes)	Transportation halfway
Soil mixer	Capacity of motor: Size of mixing axis:	22kw×4 1mϕ×1m width(Per axis)	Mixing soils
A discharge conveyer	Capacity of motor: Size of belt:	7.5kw 750㎜ width × 10m (Distance between axes)	Carrying out soil mixed
Operation room	4500×2000×H2390m		System control
Generators	250kVA		Power

※The number of the soil hoppers and the measurement conveyers changes depending on the number of soils mixed.

The case of three kinds of soils: 3 devices
The case of two kinds of soils: 2 devices

株式会社オクノコトー
OKUNOKOTOH Co., LTD.

Head office : 1-14-13,Otukacho,Takatsuki-shi,Osaka 569-0034
Phone: 072-675-0388 Fax: 072-671-9565

Hyogo office : 487,Babasaki,Higashi-honjo,Sanda-shi,Hyogo 669-1357
Phone: 079-568-6375 Fax: 079-568-6378

Kanto office : 1078-1,Kamikocho,Omiya-ku,Saitama-shi,Saitama 330-0855
Phone: 048-780-2049 Fax: 048-643-2058

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

Affiliation	JDC Corporation
Location	4-9-9　Akasaka , Minato-ku, Tokyo, 107-8466　Japan
Position:	Twister Business G, Civil Engineering Department ,Civil Engineering Division
Name/Surname	KENJI OHTSUBO
e-mail	kenji.ohtsubo@n-kokudo.co.jp

Title	**Twister Method (soil improvement device, rotary crushing and mixing method)**	
Theme classification		Prevention
		Re-use
	○	Recycle
		Reduce Co2
		Legacy
		Business to overseas
		Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020
Specific content	- The twister method can undertake homogeneous improvement of large amount of wide-ranging excavated soils generated in the site; soft rocks and concrete pieces with the diameter of 25 cm or less, clayey soil containing fine, lump, and high water-containing soils. This method is the soil improvement technology which consists of disentanglement of ground materials by impacting them with several pieces of flexible chains rotating at high speed inside the cylinder as well as homogeneous mixing with additives. Features are as follows: (1)Wider applicable geological range than conventional (2)Capable of homogeneous mixing of clayey soil lump and clayey soil with high water content (3)Capable of crushing of soft rock (grain refining) and grain adjustment (4)Capable of screening wastes, wood chips, and root stocks (with parallel vibration filter) (5)Plant line-up to cover from small-amount production to mass production The features realized by the method enables effective utilization of excavated soils that have been difficult to handle with the conventional method. About 5.45 million m3 have been utilized successfully for restoration works in Tohoku disaster-affected areas, disaster stricken areas and for airport filling project.	
Appeal point	- High quality and low cost	

Twister Method

(soil improvement device, rotary crushing and mixing method)

1. What is the technology to recycle the excavated soil by "Twister Method"?

Excavated Soils , such as **clayey soil with high moisture content** and **soil mixed with soft rock**, have been difficult to handle according to the conventional method. This new technology **can improve these soils into high-quality banking material**, which is dense and easy to compact, by stirring and mixing them homogeneously.
Utilization of this technology has enabled utilization of wide-variety of excavated soil, which in turn is expected **to reduce the work costs and improve the recyclability and quality.**
[Applicable public works fields]

1) **Banking and embankment** works of rivers
   (Work to reinforce new and existing dykes)
2) **Filled-up ground and roadbed reinforcement** work during road construction
3) Improvement of soil from excavation of structures, and backfilling

2. Outline of the Twister Method

A "Twister Method" consists of crushing and grain refining (shredding) of two or three types of excavated soils , by means of striking power of multiple flexible chains rotating with high speed inside the cylinder. This is followed by even dispersion of these soils. This method has enables **simultaneous execution of crushing and mixing**.

3. Features of the "Twitter Method"

One machine of the twitter method has the functions of both mixing and crushing.
This method has superior mixing and crushing, shredding performances, which enables mixing of wide-variety of ground materials from clayey soil to rocks.
This method ensures **highly effective dispersion of additives and superior stirring performance.**
The left figure shows comparison of the improved-soil quality between this method and manual mixing. It is evident that improved soil according to this method can attain the required quality by means of **quicklime additive rate similar to the case of manual mixing in the perfect mixing state**.

Case studies of Advanced Construction and Demolition waste(CDW) Recycling initiatives and technologies In JAPAN

Affiliation	Japan Industrial Waste Management Foundation,
Location	6-1 Kajicho 2-chome, Chiyoda-ku, Tokyo 101-0044, Japan.
Position:	Waste Resources Management Division
Name/Surname	ATSUSHI　YAMAWAKI
e-mail	yamawaki@sanpainet.or.jp

Title	**Slope stability and bearing capacity of landfills and simple on-site test methods**	
Theme classification		Prevention
		Re-use
		Recycle
		Reduce Co2
		Legacy
		Business to overseas
	○	Etc.
Technology development stage	○	Practical use
		Scheduled to be put into practical use by 2020
		Scheduled to be put into practical use after 2020

Specific content

- According to the past study, it was grasped that the waste landfills mixed with plastics, etc. had tensile resistance exerted by fibrous materials such as plastics, etc. and large frictional resistance caused by engagement of large and small wastes, etc., and the slope stability was extremely high.

-However, many construction companies believe that such waste landfills cannot used as be soft. Therefore, It is almost impossible to use it as a ground for installing a heavy structure at the disposal site.

- In addition, since the individual size of waste is much larger than that of soil, it is difficult to apply the conventional indoor soil test method to the strength test.

- Against this background, in FY2013-FY2015,with the support of the ministry of environment's Subsidy for Promotion of Comprehensive Environmental Research, We studied the strength characteristics such as the supporting capacity of waste landfill sites contaminated with plastics etc. and the mechanical test method etc and clarified basic ground strength characteristics and proposed on site test method.

- In addition, this on site test method was applied to　a large-scale waste slope collapse site in Sri　Lanka, and the usefulness was confirmed even in waste landfills outside Japan.

Appeal point

- In August 2017,We participated in "Field Survey for Safety Assessment of Slope Safety of Waste Disposal Site Meethotamulla Sri Lanka Country" by the Japan International Cooperation Agency (JICA), and provided technical support by this on site test method at this large scale collapse site.

- We provided the strength data of the waste layer to Sri Lanka · National Institute for Building Research and provided technology on a series of strength testing methods.

- Large-scale slope collapse occurs frequently at waste disposal sites in heavy rain areas such as Southeast Asian countries, and technology transfer of this on site test method can be expected.

Slope stability and bearing capacity of landfills and simple on-site test methods

Atsushi Yamawaki[1],
Waste Resources Management Division, Japan Industrial Waste Management Foundation, Tokyo, Japan (Email: yamawaki@sanpainet.or.jp)

This study discusses strength characteristics (slope stability, bearing capacity, etc.) of waste landfills through on-site tests that were carried out at 29 locations in 19 sites in Japan and three other countries, and proposes simple methods to test and assess the mechanical strength of landfills on site. Also, the possibility of using a landfill site was investigated by a full-scale eccentric loading test. As a result of this, landfills containing more than about 10 cm long plastics or other fibrous materials were found to be resilient and hard to yield. An on-site full scale test proved that no differential settlement occurs.The repose angle test proposed as a simple on-site test method has been confirmed to be a good indicator for slope stability assessment. The repose angle test suggested that landfills which have high, near-saturation water content have considerably poorer slope stability. The results of our repose angle test and the impact acceleration test were related to the internal friction angle and the cohesion, respectively. In addition to this, it was found that the air pore volume ratio measured by an on-site air pore volume ratio test is likely to be related to various strength parameters.

References

Atsushi Yamawaki, Yoichi Doi and Kiyoshi Omine; Slope stability and bearing capacity of landfills and simple on-site test methods; *Waste Management & Research,* vol. 35, Issue 7, pp.730-738, (2017)