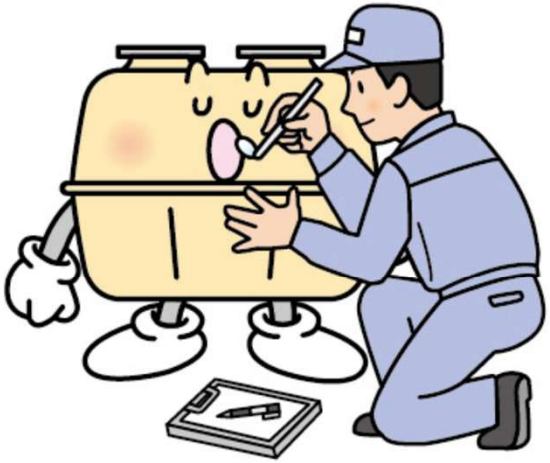
Miyagi Prefectural Authority for Living Environment
8th International Workshop on Decentralized Wastewater Treatment in Asia
21st January, 2021

Situation of wastewater management under disasters

Desludging



Operation

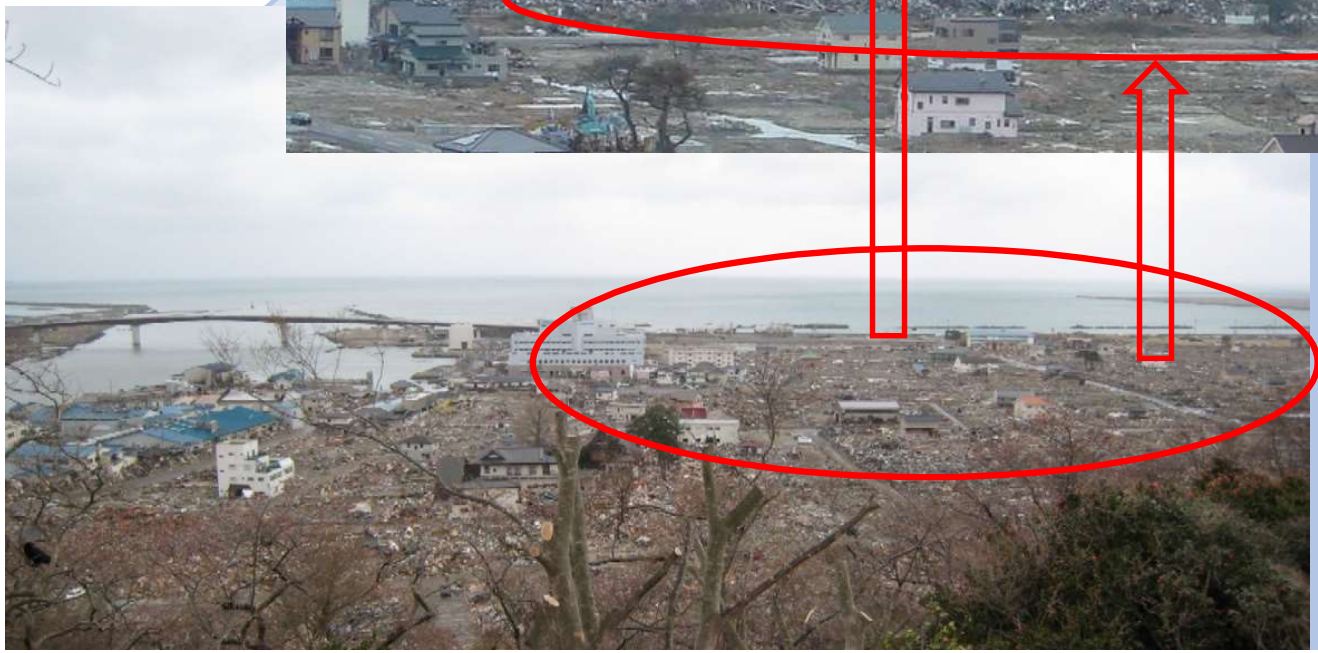
Inspection

Kikuya Shibata
Secretary General of Miyagi Prefectural Authority for Living Environment

1. Tsunami traces when the Great East Japan Earthquake
(Former Kitakami River mouth, Ishinomaki City, Miyagi Prefecture)

Damaged vehicle collection area

Temporary storage area of debris



19. April. 2011

2. Situation of damaged sewer system

Source : MLIT

Treatment facility	Immediately after the disaster	2nd May, 2011
Shut down	46	18
Damaged	63	44
Normal operation		48
unknown	11	10
Total	120	120

It took about 2 to 3 years to fully recover.

Pump facility	Immediately after the disaster	2 May 2011
Shut down	78	41
Damaged	30	31
Normal operation		36
unknown	1	1
Total	109	109

3. Johkasou is more earthquake-resilient —Outcome from the previous damage situation survey on Johksou—

○2011 Emergency investigation of damage to septic tanks after the Great East Japan Earthquake （April 2012）—Survey results of 3 prefectures (Iwate・Miyagi・Fukushia)

Survey target	Number of surveys	Emergency repair	completely destroyed
All facilities	1,099	24.6%	3.8%
Tsunami inundation area	278	52.9%	2.5%
outside of Tsunami inundation area	821	14.9%	4.3%

※ Facilities where houses were washed away were excluded from the survey

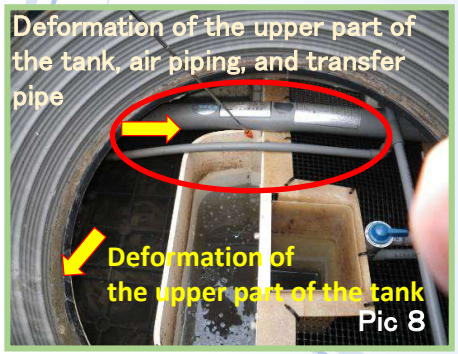
○Results of past "Large-scale earthquake damage survey" by the Johkasou function guarantee system

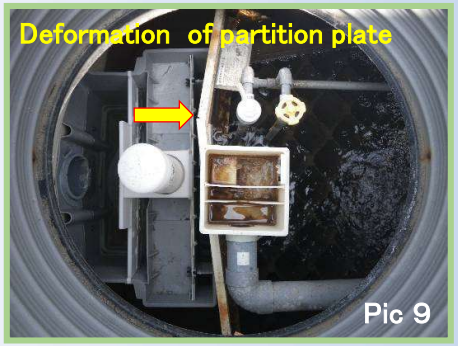
Month, Year	epicenter	Number of surveys	Number of damaged Johkasou	Damaged ratio	Investigator
5, 2003	Off Miyagi Prefecture Magnitude 7.1	1,034	5	0.5%	Miyagi Prefectural Authority for Living Environment Secretary
9, 2003	Tokachi region Magnitude 8.0	615	11	2.0%	Hokkaido Joukasou Association
10, 2004	Niigata Prefecture Magnitude 6.8	1,428	51	3.6%	Niigata Johkasou Seibi Association
3, 2007	Noto Peninsula Magnitude 6.9	971	39	4.0%	Ishikawa Johkasou Association
7, 2007	Niigata Prefecture Magnitude 6.8	1,393	60	4.3%	Niigata Johkasou Seibi Association
6, 2008	Miyagi/ Iwate Prefecture Magnitude 7.2	2,626	14	0.5%	Miyagi Prefectural Authority for Living Environment Secretary
4, 2016	Kumamoto Prefecture Magnitude 6.5	12,429	299	2.4%	Kumamoto Johkasou Association

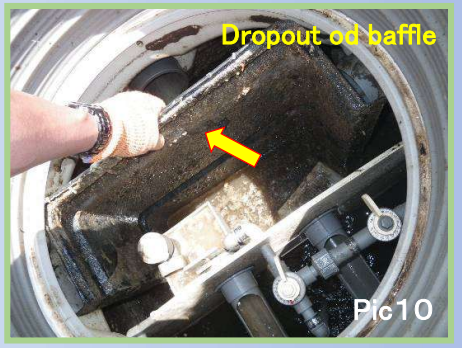
- In the sewerage system, the pipes are connected by "lines" like a mesh, while the Johkasou is resistant to ground displacement because it exists at "points" (advantages of decentalized system, Johkasou).
- The impact on Johkasou is local and limited, and even if there is a total loss, recovery within a few weeks after the start of recovery is a great advantage when considering the lives of those affected by the disaster.

4. What happened to the Johkasou?—From the damage situation—

4.1 Cases of Johkasou damage caused by an earthquake







4.2 Classification of damage for Johkasou caused by an earthquake (Classified by the presence or absence of liquefaction)

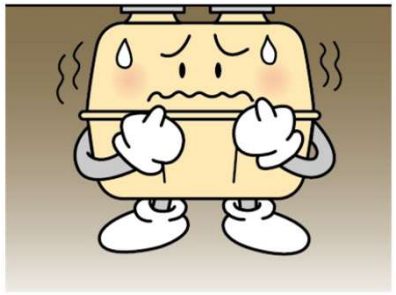
No Soil Liquefaction → **No Body Floating**

- Level 1 loosing airpipe union
- Level 2 dropping baffle/disinfection tube
- Level 2 deformation on the body
  - Level 2 deformation/damage on the partition
  - Level 2 outflow of moving bed/ contact media
  - Level 2 deformation/damage on the air pipe
- Level 3 crack occurrence on the body

Soil Liquefaction

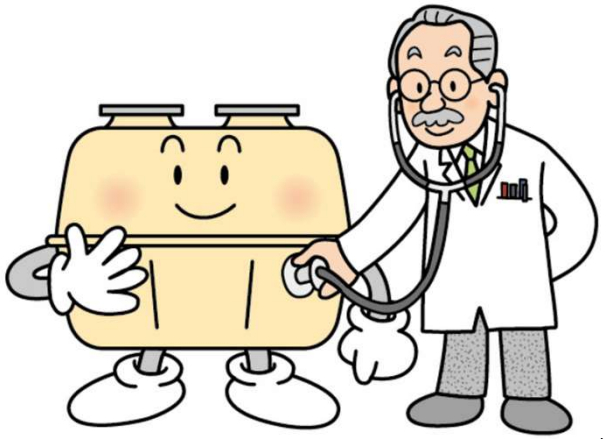
- → **No Body Floating**
  - Level 3 hard damage on the body
- → Level 4 , 5 **Body Floating**
  - Level 4 no damage on the body
  - Level 5 damage/deformation on the body
  - Level 0 poor gradient on the connection
  - Level 1 damage on the connection
  - Level 1 damage on the air pipe connection
  - Level 1 trouble on the slab/raising
  - Level 1 deformation/damage on the body(upper side)

Subsidence of Backfill part



Frequency of damage

- **Frequently**
- **Sometimes**
- **rarely**



4.3 Estimation of damage to the Johkasou based on the previous large-scale earthquakes

Seismic intensity	Damage estimation of Johkasou	
	Plate boundary type earthquake (M7)	Direct type earthquake (M6)
Over lower 6	**Whole** • Body • Inflow/discharge(pit) pipe • Air pipe • Other features Expansion of damage	**Whole** • Body • Inflow/discharge(pit) pipe • Air pipe Expansion of damage
Upper 5		
Lower 5	**A part of** • Body • Inflow/discharge(pit) pipe • Air pipe	
4		**A part of** • Body • Inflow/discharge(pit) pipe • Air pipe
Damage estimated range	Wide range	Around the epicenter area

※ If the magnitude (M) increases 1, the energy of the seismic wave will increase by about 30 times, and if it increases 2, it will increase by about 1,000 times.

4.4 Future of Johkasou construction (disaster prevention / mitigation)

The three points of Johkasou damage that can be seen from the case of the Great East Japan Earthquake

① The Johkasou with support post, there is almost no surfacing due to liquefaction.

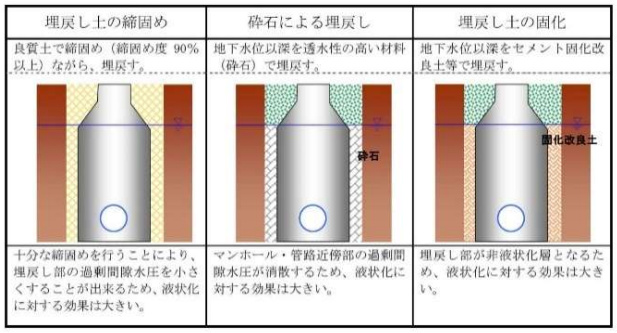
② Most of the surfacing of the body is due to the liquefaction of the backfilled part.

③ Floating prevention metal fittings are intended for static groundwater and are not supposed soil liquefaction around the Johkasou.

Concept of disaster mitigation measures

Preventing soil liquefaction of backfill part is the "basic consept of an earthquake-resistant Johkasou."

Prevention method on Soil liquefaction of sewer



Eliminate one of the following three factors which lead soil liquefaction.

① The ground water level in the backfill area is high.

② The grain size distribution of soil used for backfill area is easily liquefied.

③ Low degree of sand compaction of backfill area.

4.5 Classification of damage for Johkasou caused by tsunami (flood) and damaged case of Johkasou

Tsunami/ flood damage

When the inundation depth is shallow

Flooded above floor level (below than 2m)

When the inundation depth is deep

Inundation on the second floor or more (higher than 2m)

The damage to the building is also enormous

2nd damage

When removing debris, etc.

Blower outflow/flooding
- There is a high possibility of electric leakage

Inflow of sediment/sludge
- Inflow of seawater
- Abnormality in bubbling / transfer
- Inflow of oil
- Collapse of disinfection cylinder

Manhole outflow
- Large inflow of rubble, sediment, etc.
- Collapse of disinfection cylinder
- If the inundation depth is shallow, the manhole can be locked to prevent outflow.

Erosion of surrounding ground/Slab outflow
- Exposure of the body and piping
- Damage to the body

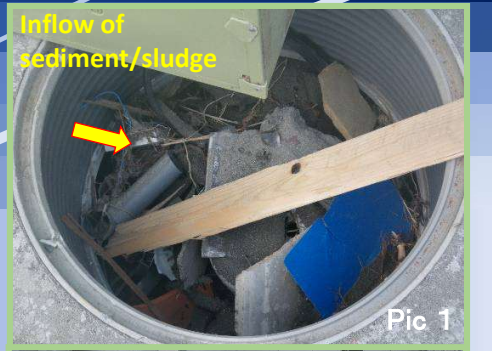
(Since the main body is underground, the damage is less than that of the building.)

Significant damage to the body
- Most of the damage to the main body is due to heavy machinery such as backhoe.

(A mark is required when using the Johkasou continuously)

Frequency of damage

Frequently
Sometimes
rarely



Pic 1

Pic 2

Pic 3

Pic 4

4.6 Judgment of availability of provisional use

In the case of the Great East Japan Earthquake, it is difficult to judge whether “Available" or not without sufficient experience, except for a clear situation of floating and an abnormal low water level in the Johkasou immediately after the earthquake. Therefore, it has been judged just "provisional use is possible" or "non available". However, as conditions for "provisional use is possible", it is necessary to satisfy the following conditions.

① The inflow water and the water in the tank are not leaking or overflowing.
② Disinfection process is certainly done.

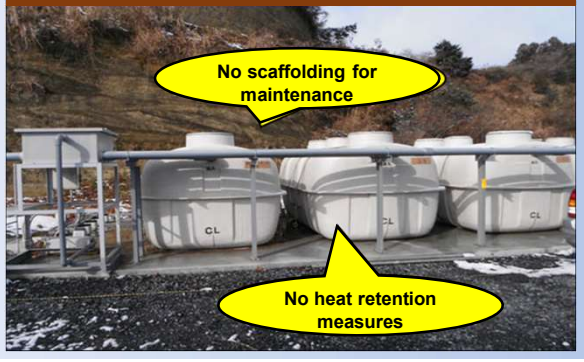
Under those conditions, even if the blower is stopped due to a power failure, electric leakage, damage, etc., provisional use is possible by performing simple processing.
As stated in the manual provided by Ministry of the Environment, the period of provisional usage is about 3 months at the maximum, and during this period the restoration work shall be completed.

5. Johkasou installed at temporary housing
5.1 Situation

- In the Great East Japan Earthquake, Johkasou can be restored and installed more quickly compared with sewers or rural sewerage system which take a long time to recover, therefore Johkasou have been widely adopted in temporary housing and temporary stores.
  Approximately 1,700 units were installed in Iwate, Miyagi, and Fukushima prefectures.
- In the mountainous area or area with many small scale colonies, installation of Johkasou in such temporary housing seems the most effective (financially and timely) development procedure.
- However, since it was necessary to construct a huge number of Johkasou along with temporary housing in a very short term, many of the Johkasou had been installed on the ground (not underground), and there were problems in terms of maintenance works and its system.
- In addition, it was an urgent move-in in a disaster, there was a problem which a large inflow of fats & oils and impurities, therefore, it was necessary to explain to the residents how to use the Johkasou installed at the temporary housings.

improvement approach for maintenance (sign boards and numbering)

No scaffolding for maintenance
No heat retention measures



Inadequate screen equipment

5. 2 Installation example of Johkasou at temporary housing

Iwate Prefecture
(underground ：35 PE)

Fukushima Prefecture
(Semi-underground installation＋embankment：
45 EP×2 units)

Iwate Prefecture
(Semi-underground installation、
heat retention measures：42 PE)

Iwate Prefecture
(Ground installation、No heat retention measures：
90 PE×6 units＋30 PE)

6. Status of Johkasou installed in evacuation shelters

(Source: (2016) Damage situation survey on Johkasou by Kumamoto earthquake, Association of Johkasou, kumamoto.)

In Minamiaso village (Kumamoto earthquake: 14th April, 2016)

① Kukino General Welfare Center

The total number of evacuees were 3,370 peoples until 18th May. There were several days when the maximum number of evacuees exceeded the PE of Johkasou (287 PE) , however, there were no problems with the treatment function of the Johkasou, and the treated water quality was stable.

treatment process	PE	item		11, Apr	18, Apr	22, Apr	20, May	27, May
contact aeration system	287	Number of evacuees			670	1,471	3,370	※
		Water quality item	pH	7.1		7.8	7.3	7.7
			DO	3.8		4.2	3.3	7.7
			Transparency	100		100	100	100
			Residual chlorine	0.2		0.2	0.2	0.2
			Chlorine amount	1,000	1,000	1,000	1,000	1,000

※all evacuees moved out by May 18

② Minamiaso Junior High School Gymnasium

The total number of evacuees were 13,072 peoples until 24th May. On 14th April, a power outage of the discharge pump and damage (displacement) on the inflow pipes were monitored, however, by 19th April restoration works such as emergency generator installation has taken. There were 800 evacuees at maximum in the term, and it greatly exceeded the PE of Johkasou (66 PE), however, there were no problems with the treatment function and the treated water quality was stable.

treatment process	PE	item		14, Apr	18, Apr	25, Apr	18, May	17, Jun	13, Jul
moving bed aeration system with flow control tank	66	Number of evacuees			2,000	5,522	12,292	13,072	※
		Water quality item	pH	8.3		8.0	8.1	7.7	7.6
			DO	4.2		4.8	4.4	4.0	4.5
			Transparency	30		30	30	30	30
			Residual chlorine	0.2		0.2	0.2	0.2	0.2
			Chlorine amount	-	-	-	-	-	-

※ all evacuees moved out by 24th May

7. 2011.3.11 “Records and experiences of the Great East Japan Earthquake”

You can download “Records and experiences of the Great East Japan Earthquake” from the URL below.

http://www.m-seikatsukankyo.or.jp/other/report311/

Thank you for your attention.