Lessons Learned from Damage to Drinking Water Supply System in the 2016 Kumamoto Earthquake in Japan

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Contents

- Outline of earthquake and damage
- Damage to pipeline in liquefaction area
- Damage to air valve
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2016 Kumamoto EQ

- Date and time：2016.4.16 1:25 local time
- Magunitude：Mj=7.3、Mw=7.0
- JMA Seismic Intensity：

  7 ：Nishihara, Mashiki

  6+:Minami aso, Ozu, Uki, etc.

- Damage：

  Totally collapsed houses: more than 8,000

  49 death and 1 missing after the mail shock

PGA & PGV in Kumamoto EQ

Fore Shock

	Site Name	PGA(m/s/s)	Site Name	PGV(m/s)
1	KiK-net Mashiki	9.25	Mashiki-machi, Miyazono	1.38
2	Mashiki-machi, Miyazono	8.15	KiK-net Mashiki	0.92
3	Kumamoto nishi ku, Kasuga	7.36	K-net Kumamoto	0.72

Main Shock

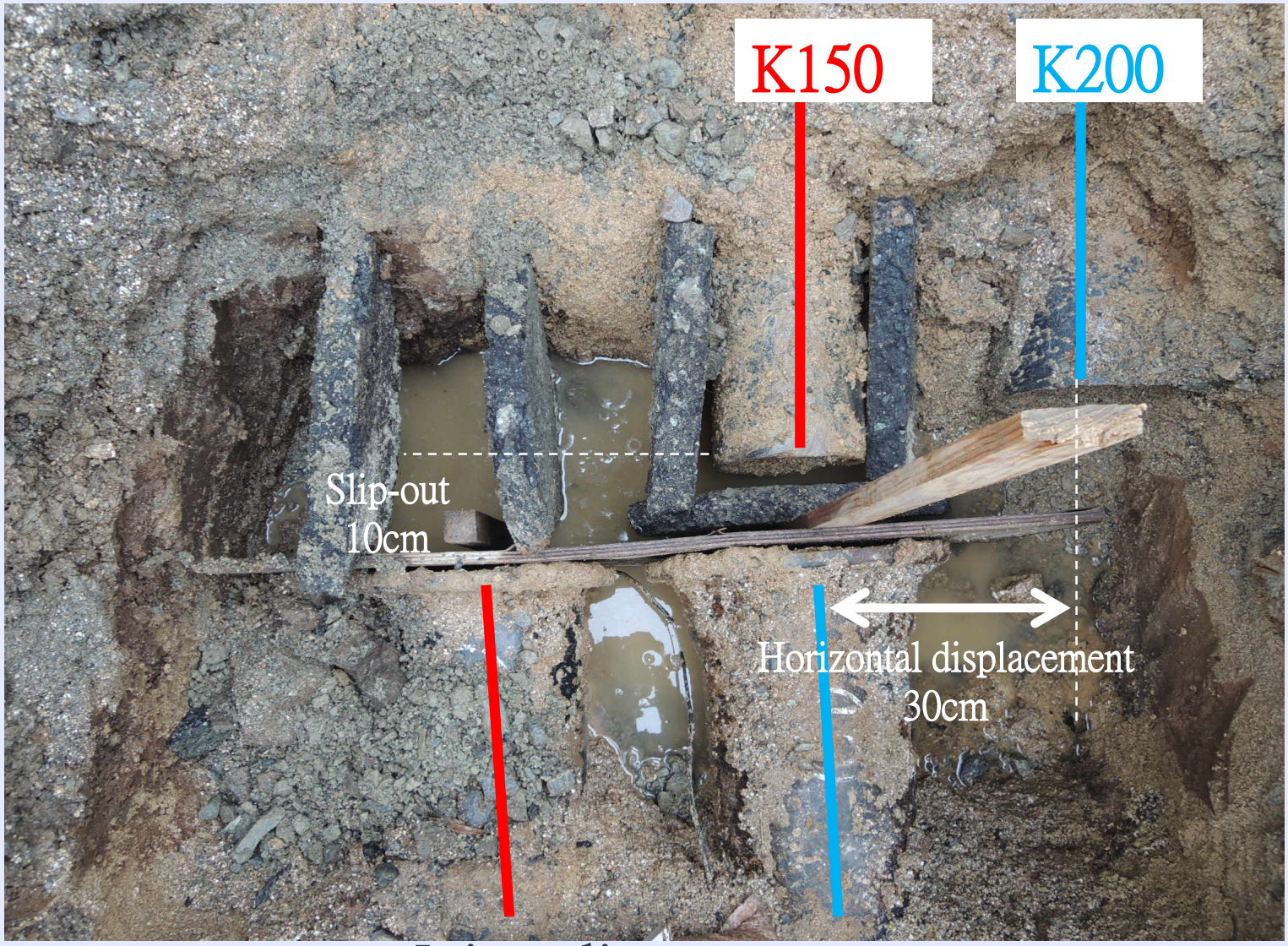
	Site Name	PGA(m/s/s)	Site Name	PGV(m/s)
1	Ozumachi, Ozu	17.54	Nishihara-mura, Komori	2.56
2	KiK-net Mashiki	13.14	Mashiki-machi, Miyazono	1.82
3	Minamiaso-mura, Kawayou	12.92	Minamiaso-mura, Kawayou	1.39


Horizontal displacement 2.0m

DIP (K-type) φ100

Pipe bending and joint slip-out

DIP (K-type) φ150 ， φ200



Joint slip-out

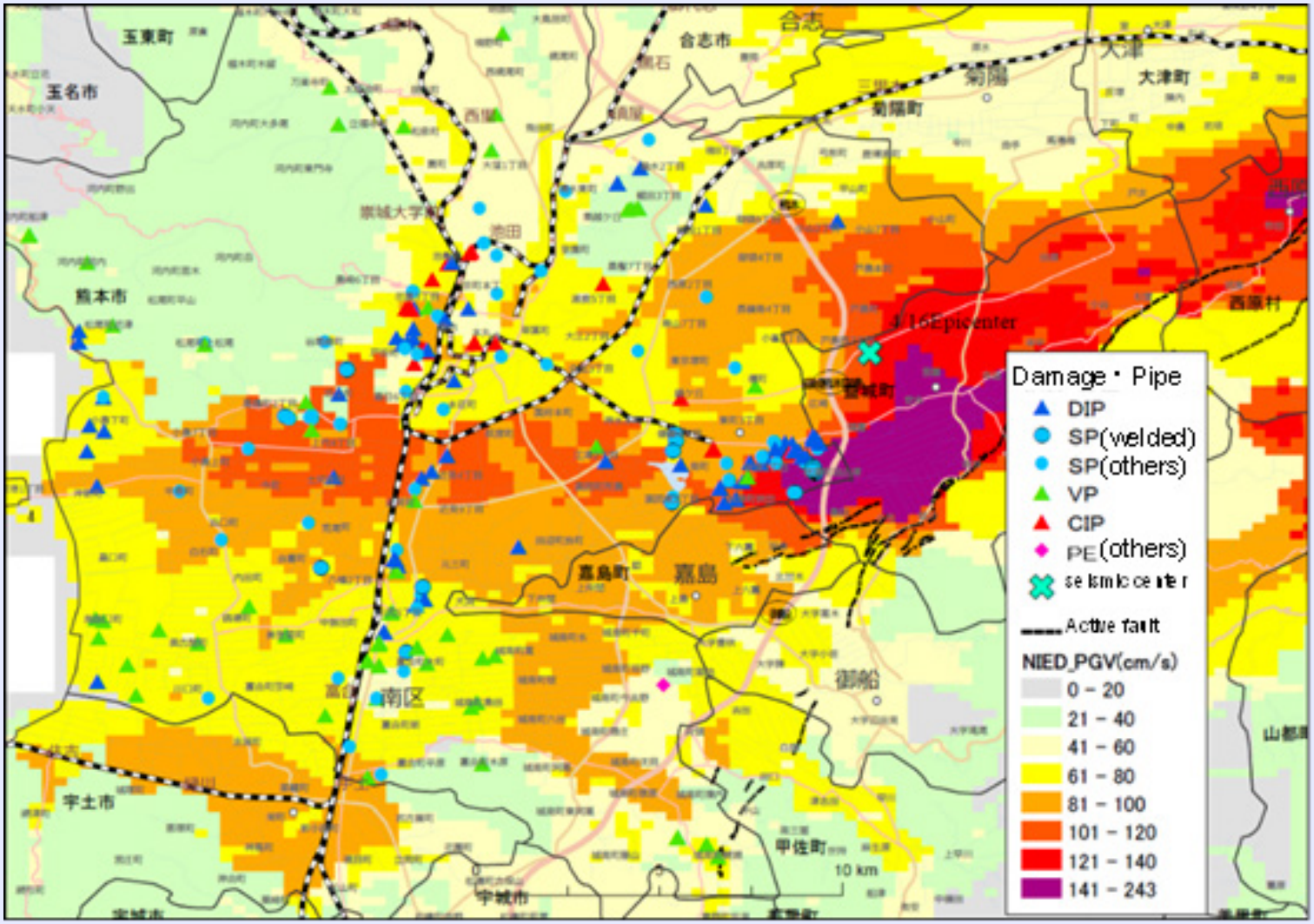
HIVP φ１００　at normal fault

写真：ダクタイル鉄管協会提

Damage to intake well

Suspension of water supply at all household (about 326,000) due to turbidity

Location of damage to Pipe



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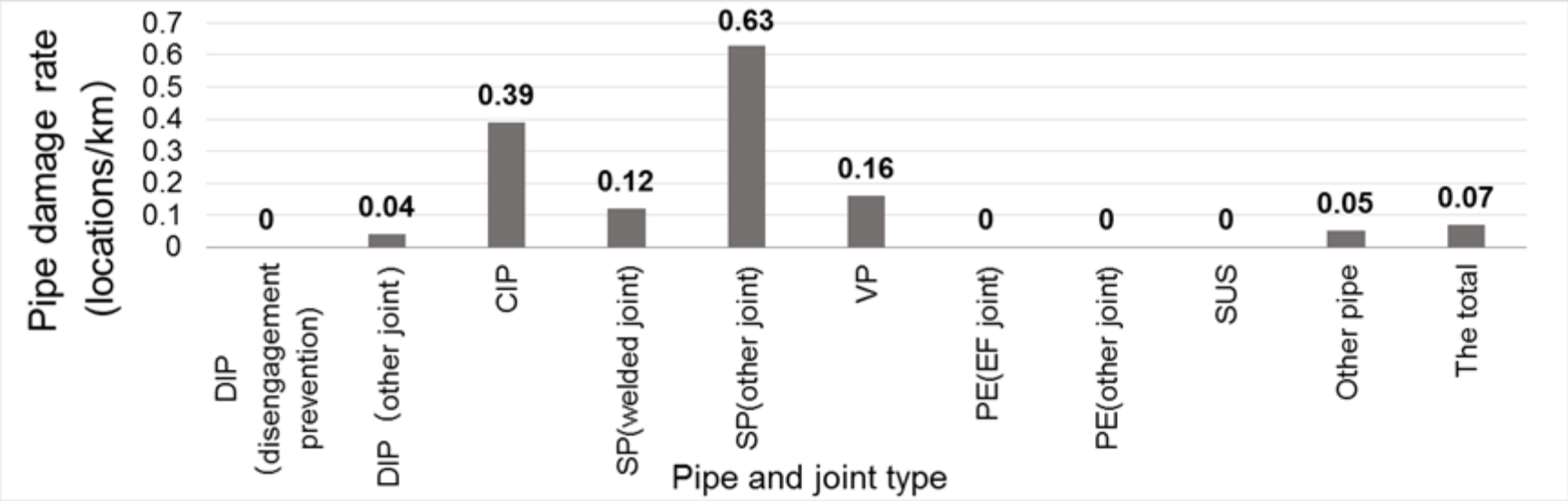
Mesh data of PGV distribution in the 2016 Kumamoto Earthquake

Damage rate of each pipe type



Pipe material *1	DIP (disengagement prevention)	DIP (other joint)	CIP	SP (welded joint) *2	SP (other joint) *3	VP	PE (EF joint)	PE (other joint)	SUS	Other pipe
Pipe damage (no. of locations)	0	72	36	8	59	55	0	0	0	3
Pipe Installation length (km)	583	1882	92	68	93	346	97	8	5	63

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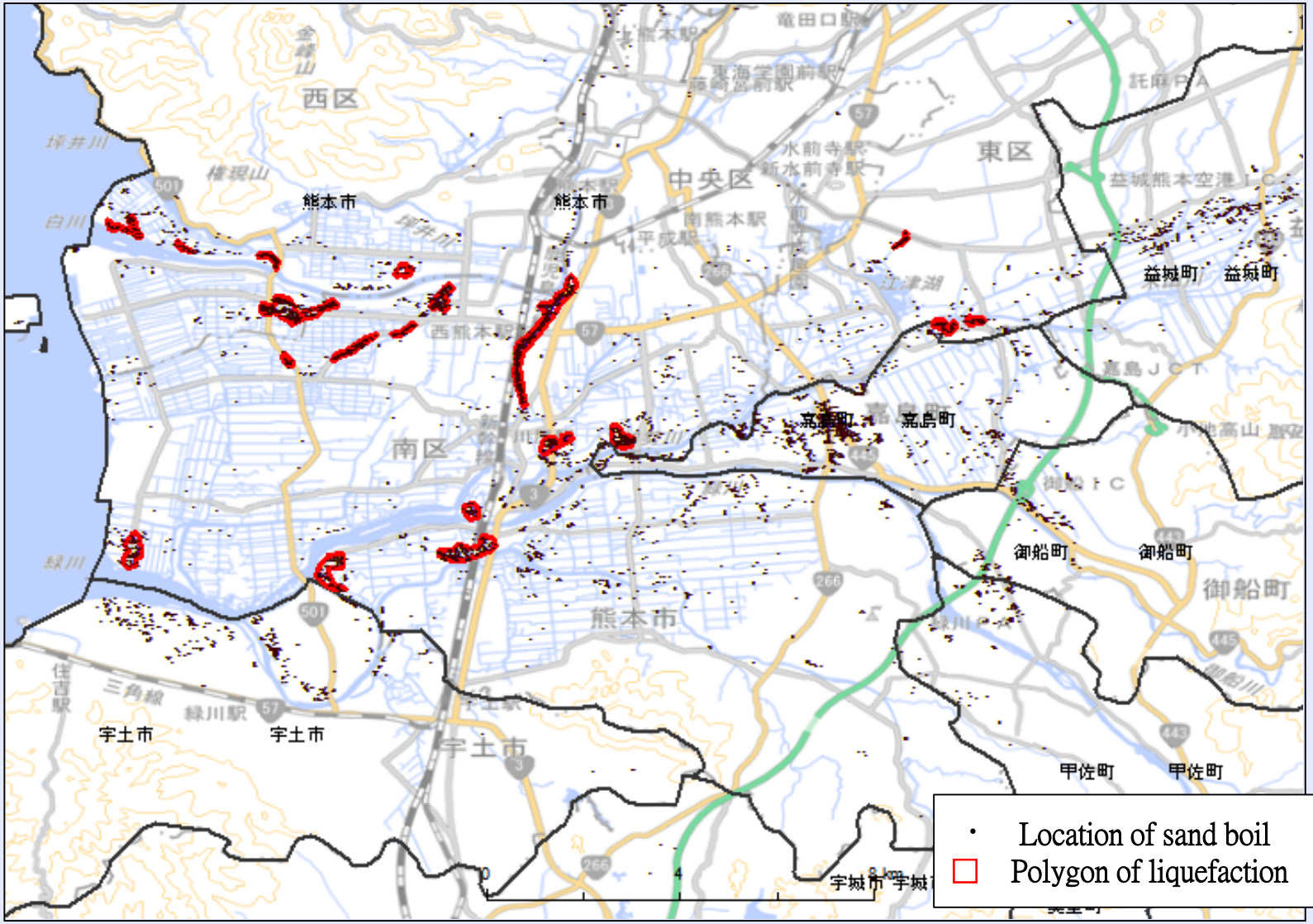
Liquefaction in Kumamoto City

Liquefaction in Kumamoto City

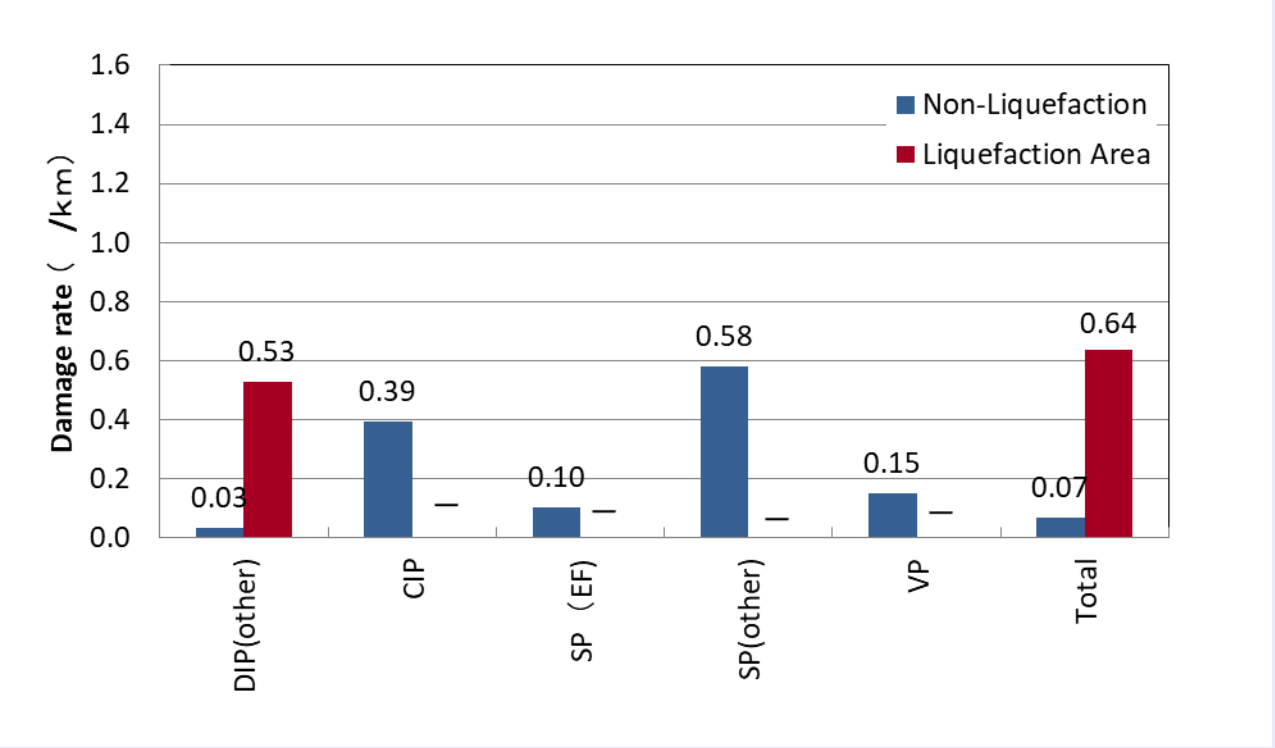
Liquefaction area in Kumamoto City



National Research Institute for Earth Science and Disaster Resilience. Mesh and point data of liquefaction distribution in the 2016 Kumamoto Earthquake

Piping length and Damage rate

Pipe type	DIP（ER）	DIP(other)	CIP	SP(welded)	SP(other)	VP	PE(EF)	PE(other)	SUS	Other	Total
Pipe length（km）	5.3	15.1	1.1	0.5	0.1	0.5	0.4	0.0	0.0	1.2	26.7
Number of location		8		3	3	3					17
Damage rate（/km)※	0	0.53	0	-	-	-	0	0	0	0	0.64



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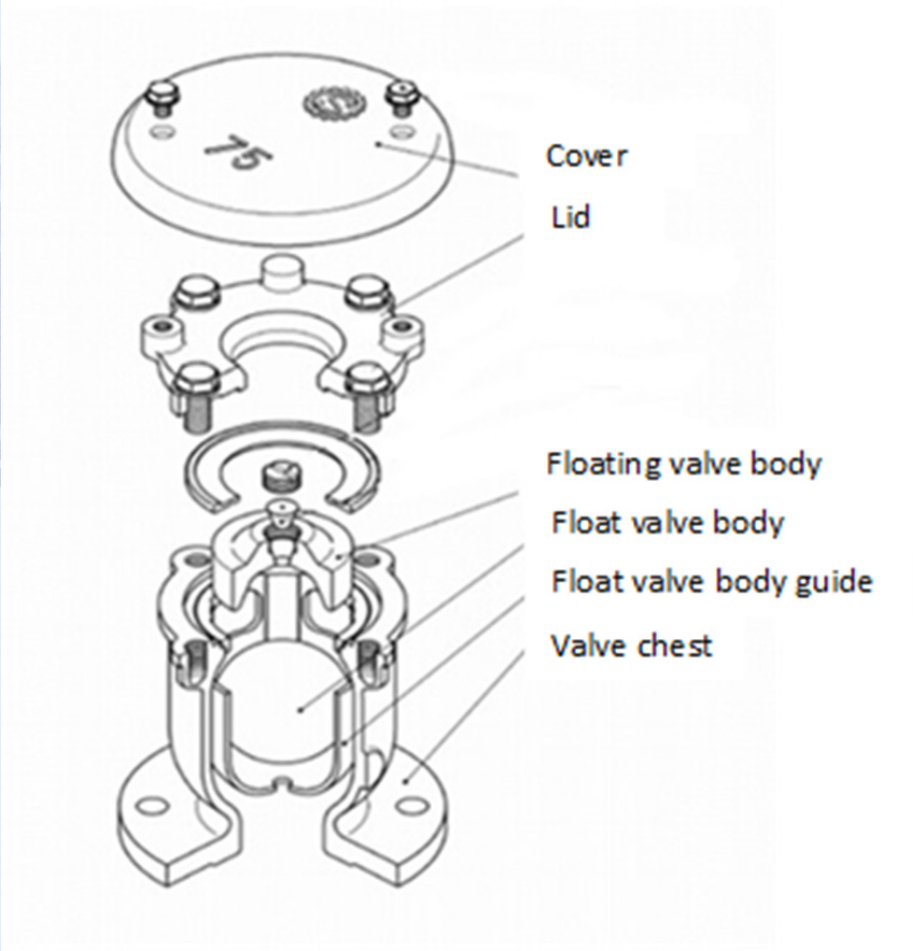
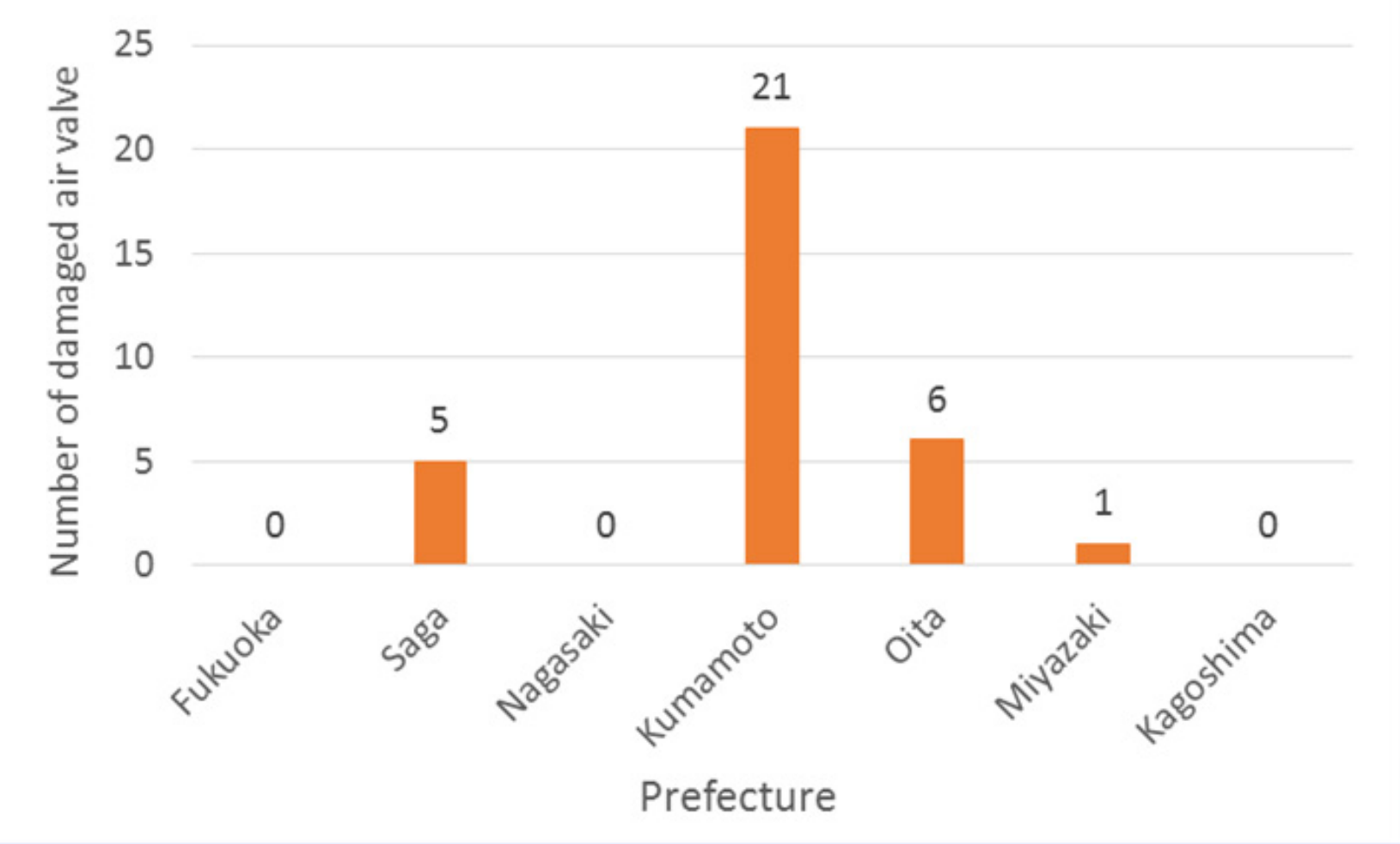
Damage to valve

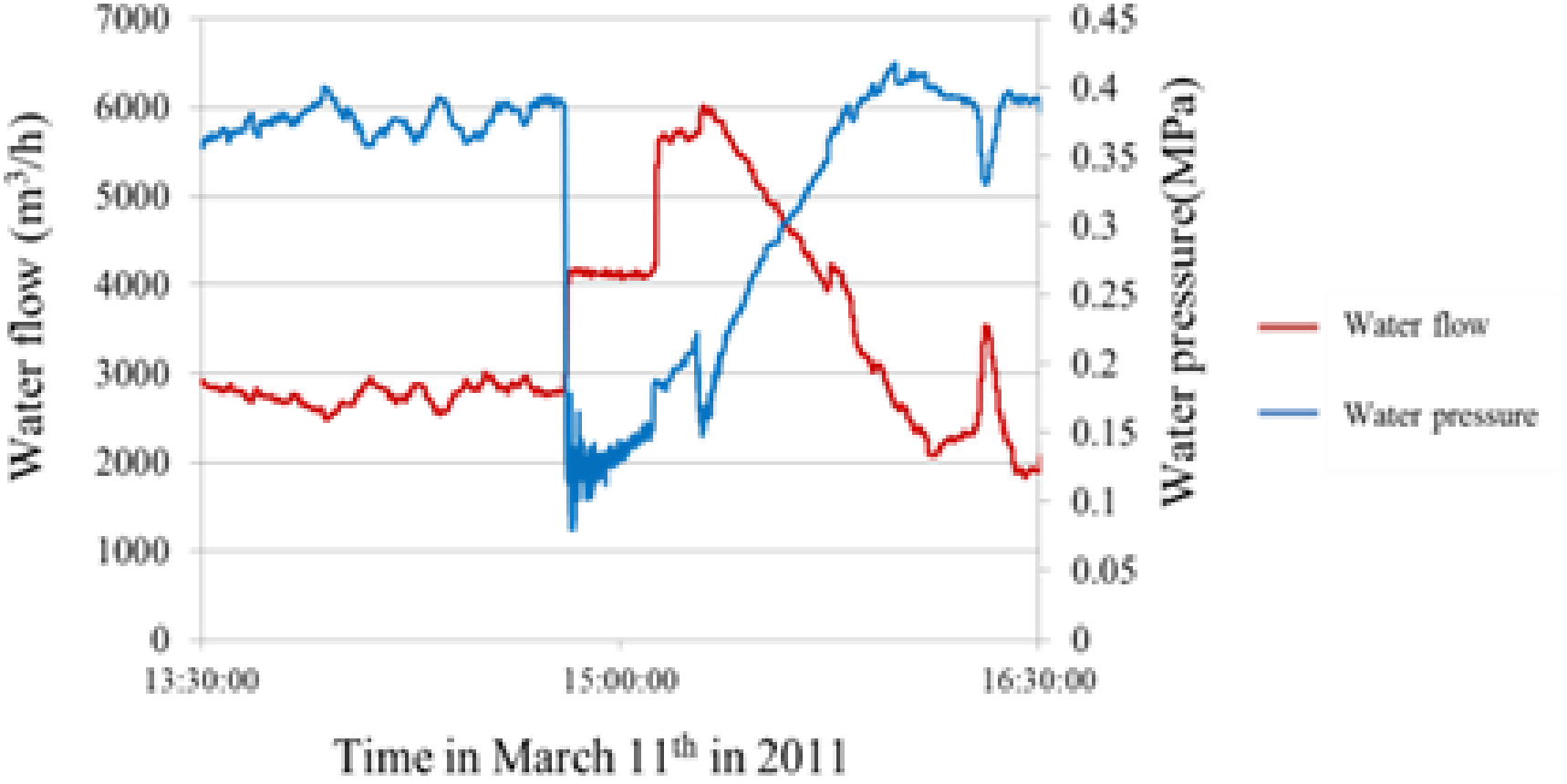


Damage to valve

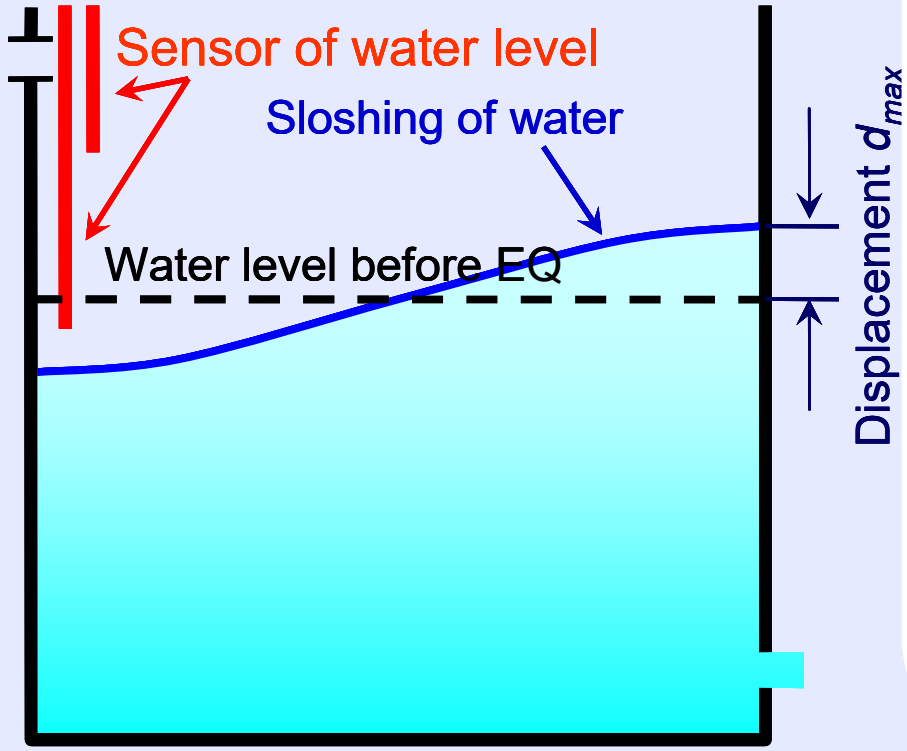
Location of damage to valve



Flow rate and water pressure



Mechanism of draw of water



EQ Occurs

Sloshing of water in receiving water tank

Sensor detects water level becomes low

Draw of water

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Concluding remarks

- Pipe length of liquefied area is about 0.8% of the total length in Kumamoto City. The damage rate of pipelines in liquefied area was however about ten times of that in non-liquefied area.
- The pipelines crossed a surface faulting suffered severe damage. The countermeasure for pipeline crossed a fault is necessary in the future.
- The damage to air valve was caused by not only strong ground motion but also abrupt decrease of water pressure in a pipe. The cause of abrupt decrease of water pressure in a pipe just after an earthquake should be clarified.