Introduction of Hazard Resilient Ductile Iron Pipe

Mitsuru UCHINO, Engineer
Kubota Corporation

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Kubota History

Corporate name	**KUBOTA Corporation**
Established	1890
Capital	¥84.1 billion
Revenue (consolidated)	¥3,016.3 billion
Employees (consolidated)	52,094
Global expansion	Over 120 areas
Overseas sales	79.0%

(as of December 31, 2024)

Head Office building (Osaka)

Head Office

2-47, Shikitsuhigashi 1-chome, Naniwa-ku,
Osaka 556-8601, Japan
TEL.(81)-6-6648-2111

Tokyo Head Office

Kyobashi Trust Tower
1-3, Kyobashi, 2-chome,Chuo-ku,
Tokyo 104-8307, Japan
TEL.(81)-3-3245-3111

Kubota History

Developing Businesses to Benefit Society Since our Founding

Kubota began its business by manufacturing and selling cast metal products.
Since then, we have offered various products contributing to improving human lives and society.

135 years
Founded in 1890

Kubota History

For Earth, For Life
Kubota

Supporting the World's Food, Water, and Environment

Food

Contributing to the abundant and stable production of food by streamlining of agriculture.

Circulate
Restore
Maintain

Water

Contributing to supply and to restore reliable water by enhancing water infrastructures.

Environment

Contributing to create a comfortable living environment and to preserve the global environment by enhancing social infrastructures.

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Kubota Ductile Iron History

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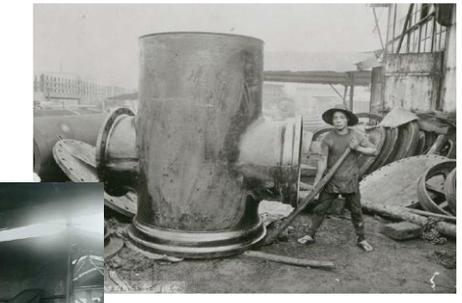
1890-1900s

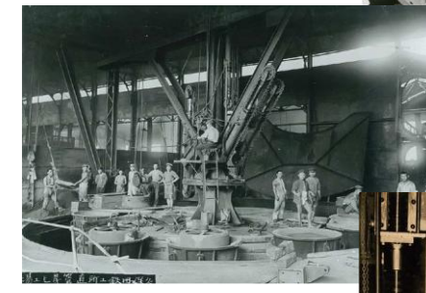
Demand for Water Infrastructure Rose as Infectious Diseases, such as Cholera, Spread

Until the Production of Domestic Iron Pipes

Kubota started producing Cast Iron Pipes in 1893, then four years later, succeeded in manufacturing straight pipes.

Continuous efforts in inventing casting equipment and methods, Kubota succeeded to establish Centrifugal Casting in 1936.



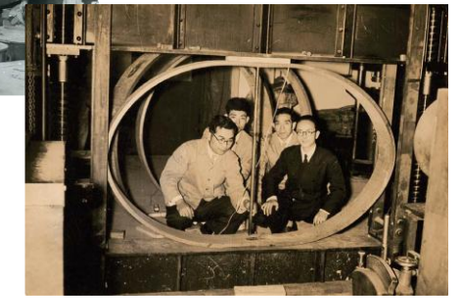


1940-1950s

Water Infrastructure is Restored, Overcoming Resource Shortages

Started Developing Waterworks Supplies -The Origin of Kubota's Water-Related Business

A new material, ductile cast iron (DCI) developed in the U.S., shocked the industry in 1948. Kubota prepared for the full-scale mass production of iron pipes in 1950. Kubota was the first in Asia in developing the Metal Mold Centrifugal Casting Technology.



1950-1960s

Modernization and the Development of Larger Water Infrastructures Brought on by Rapid Economic Growth

Challenge to Mass-Production of Large-Diameter Ductile Iron Pipes with Centrifugal Casting

Kubota Ductile Iron History

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1970-1990s — Unprecedented Economic Growth Continued across the World

Delivering World Class Water Infrastructure from Japan to Globe

Kubota had a global market presence and has significantly expanded its global footprint. Today we support infrastructure in more than 70 countries.
High Quality of Kubota Pipes are respected for their durability and performance.

1990s- — Providing a Reliable Lifeline by Accurately Grasping the Changing Needs

Developing Public Infrastructure in Preparation for Natural Disasters

In 1974, Kubota originated first Earthquake-Resistant Ductile Iron Pipe, "ERDIP".

Kubota developed GX-type earthquake-resistant pipe in 2010.
It is characterized by its ease of installation and 100-year service life with high resistance to natural disasters.

Future… — *Kubota's Technological Strength that Continues to Support World's Water Infrastructure*

Supply Record: Palau

Year	Project	Size (mm)	Total length (m)
1987	The Project of Water Supply (Ngeremlengui-State)	150	900
1991-1992	The Project for Improvement of Water Supply	100-300	12,200
2016-2017	The Project for Improvement of Water Supply System	80-400	9,052

Supply Record: Oceanian region

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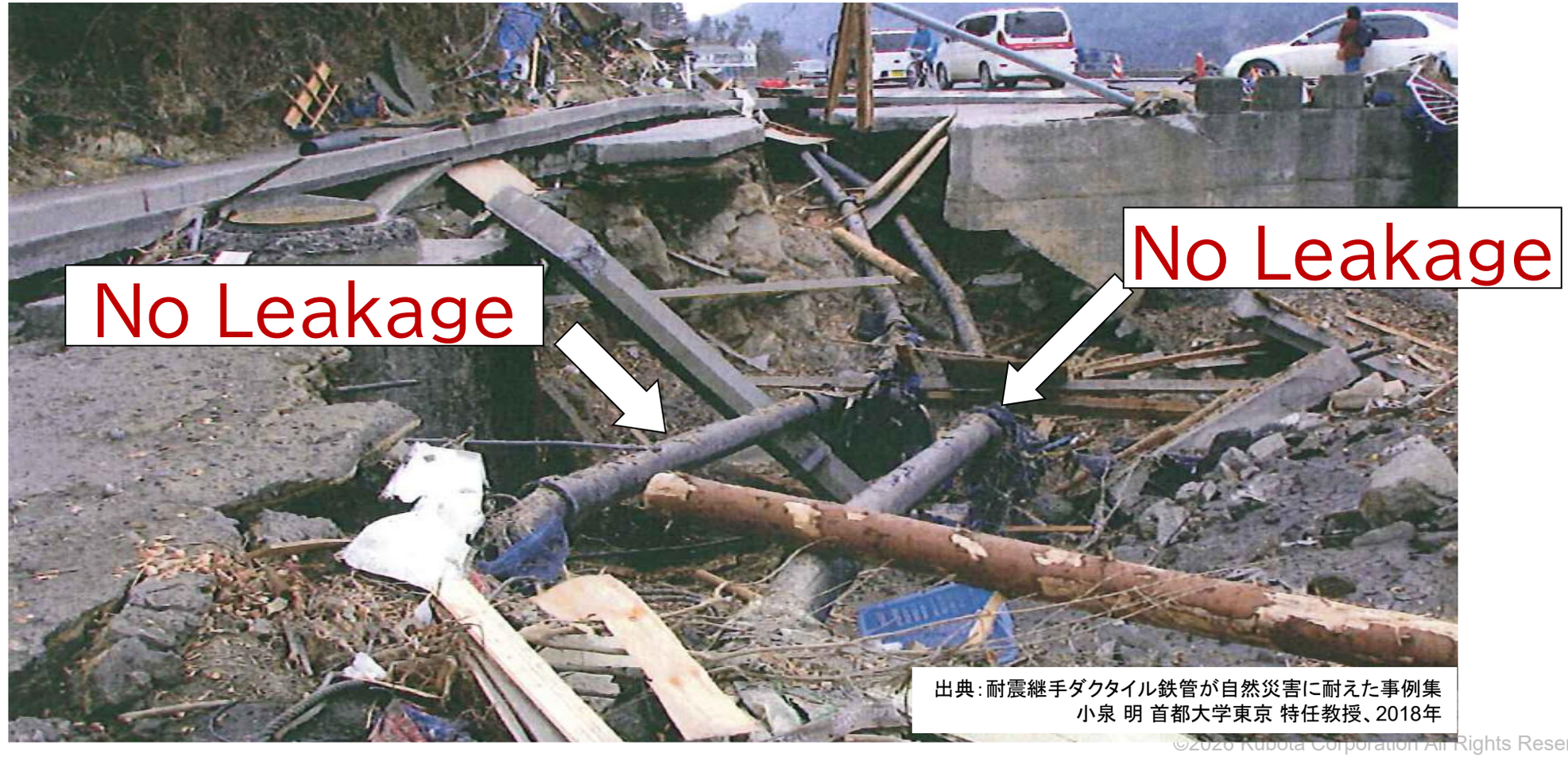
Year	Country	Project	Size (mm)	Total length (m)
1980	Papua New Guinea	Port Moresby	600-800	9,800
1982	Papua New Guinea	Port Moresby	300-1000	6,000
1987	Marshall	Project of Water Supply in Majuro Atoll	100-350	15,000
1995	Papua New Guinea	Project of Water Supply in Port Moresby	100-1100	5,196
2000	Tonga	-	150-500	13,872
2005	East Timor	Project for Improvement of Water Supply in Dili	80-250	16,114
2006-2007	East Timor	Project for Improvement of Water Supply in Same and Ainaro	80-300	24,322

Contents

- Road collapse by typhoon
- Place: Shiga
- Pipe size: 100 and 150 mm (NS-type)

出典：耐震継手ダクタイル鉄管が自然災害に耐えた事例集
小泉 明 首都大学東京 特任教授、2018年

- Road collapse and **Tsunami** by the 2011 Great East Japan Earthquake(M9.0)
- Place: Miyako-city, Iwate
- Pipe size: 200 mm (NS-type)



出典：耐震継手ダクタイル鉄管が自然災害に耐えた事例集
小泉 明 首都大学東京 特任教授、2018年

- **Liquefaction** caused by 1995 Kobe Earthquake (M7.3)
- Place: Kobe-city, Hyogo
- Pipe size: 700 mm(S-type)

出典：耐震継手ダクタイル鉄管が自然災害に耐えた事例集
小泉 明 首都大学東京 特任教授、2018年

- We renamed HRDIP from ERDIP to reflect that these lineups can withstand not only earthquake but also other natural disasters in Japan.

HRDIP

Hazard Resilient Ductile Iron Pipe

HRDIP Diameter Range [1)]

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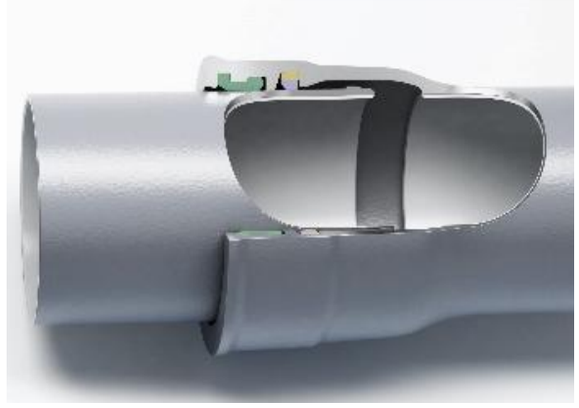
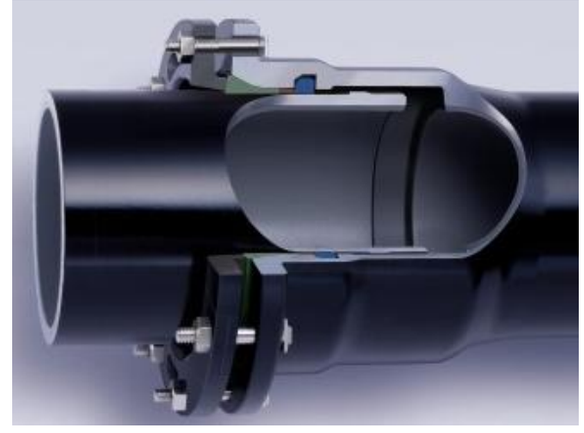
Diameter (mm)		
75-450	500-1000	1100-2600
GX type [2)]	NS type	S type
		
Push-on joint	Mechanical joint	Mechanical joint

Note:
1) HRDIPs are conforming to JIS (Japanese Industrial Standards).
GX type can provide 6”, 8” and 12” AWWA size.
2) Metallic zinc alloy coating is applied to GX-type products.

Joint Structure Comparison

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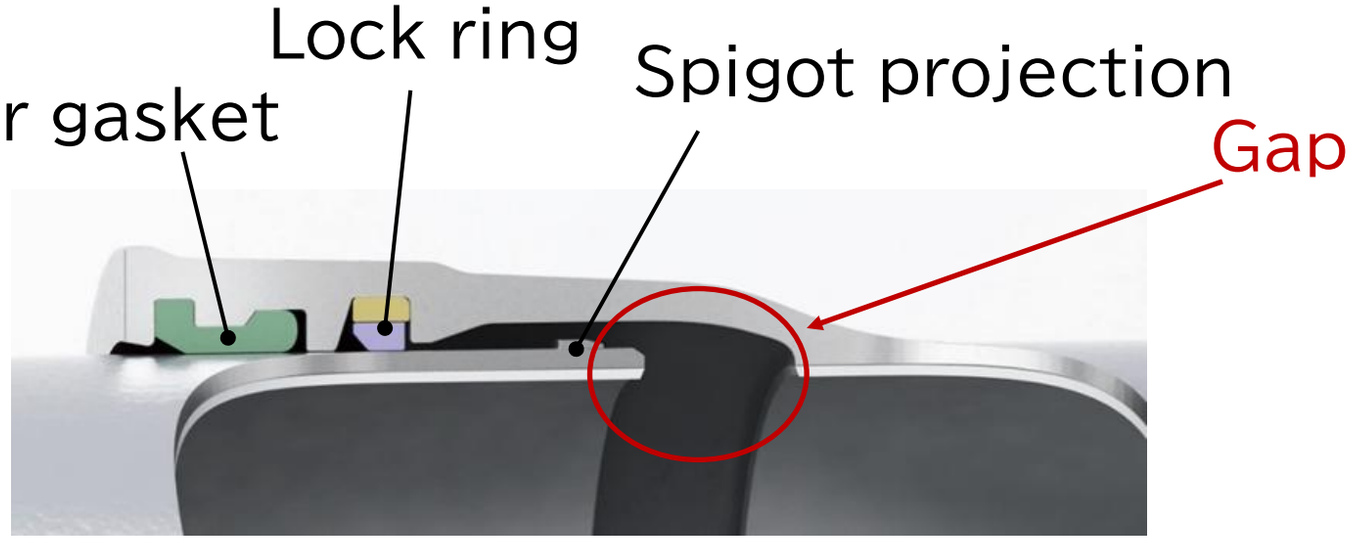
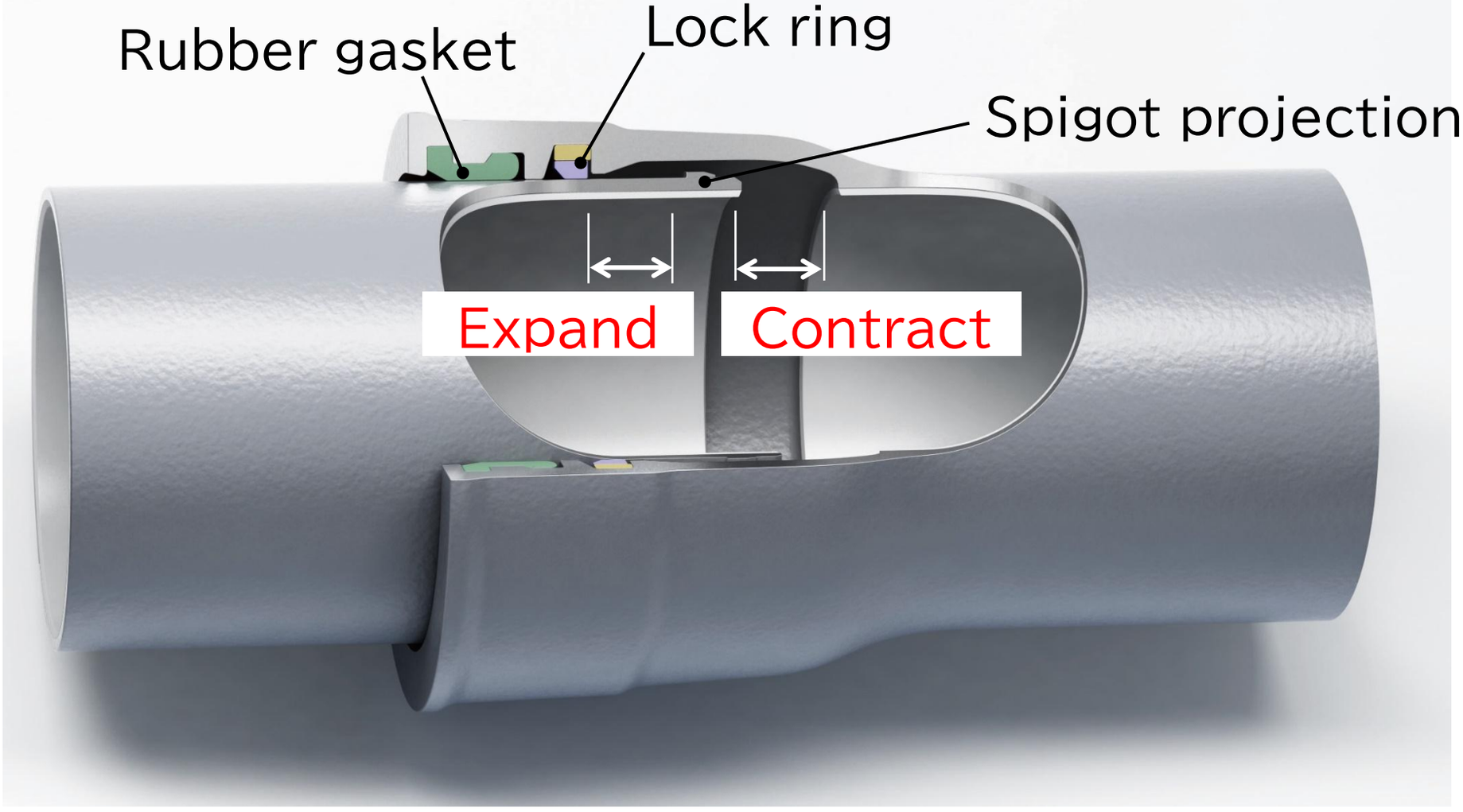
HRDIP
(GX type)



Standard
pipe

Joint Detail of HRDIP for DN75-450 (GX-type)



ISO16134-2020 Classification of pipeline components

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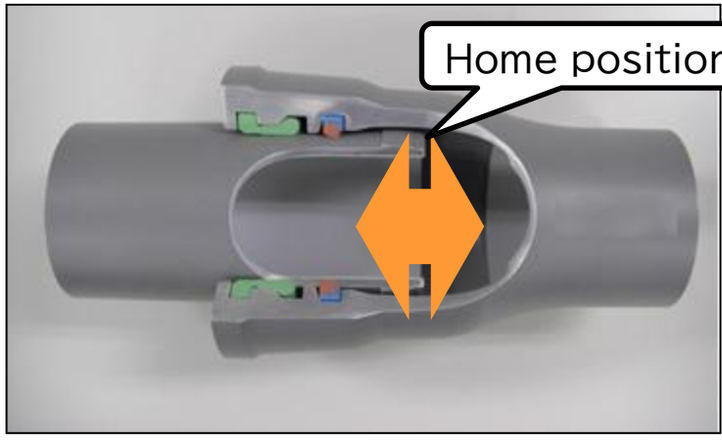
Parameter	Class	Component performance
Expansion/contraction Performance	S-1	±1% of *L* or more
	S-2	±0.5% to less than ±1% of *L*
	S-3	Less than ±0.5% of *L*
Slip-out resistance	A	3 *d* kN or more
	B	1.5 *d* kN to less than 3 *d* kN
	C	0.75 *d* kN to less than 1.5 *d* kN
	D	Less than 0.75 *d* kN
Joint deflection angle	M-1	*θa* or more
	M-2	*θa*/2 to less than *θa*
	M-3	Less than *θa*/2

L: component length (mm)　*d:* nominal diameter of pipe (mm)
θa: joint deflection angle as shown below

Pipe size(mm)	80-400	450-1000	1100-1500	1600-2200	2400-2600
θa	8°	7°	5°30′	4°	3°30′

Performance of HRDIP

1) Expansion and contraction



Performance: ±1% of pipe length

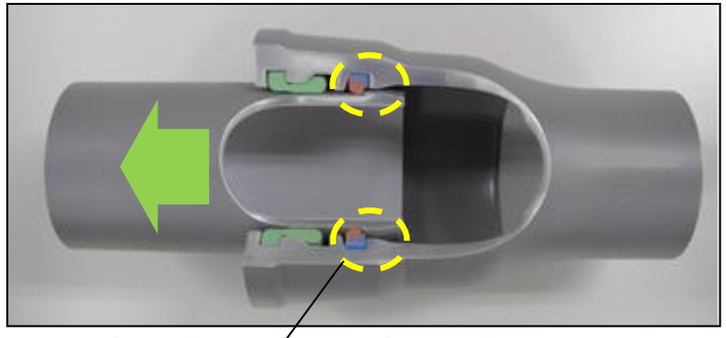
e.g. Size 100 mm pipe

Nominal pipe length: 4000 mm

-> Joint can expand / contract 40 mm.

Note: Fitting joint cannot expand or contract.

2) Slip-out resistance



Lock ring and spigot projection prevent the joint from being slipped out.

Performance: 3D kN

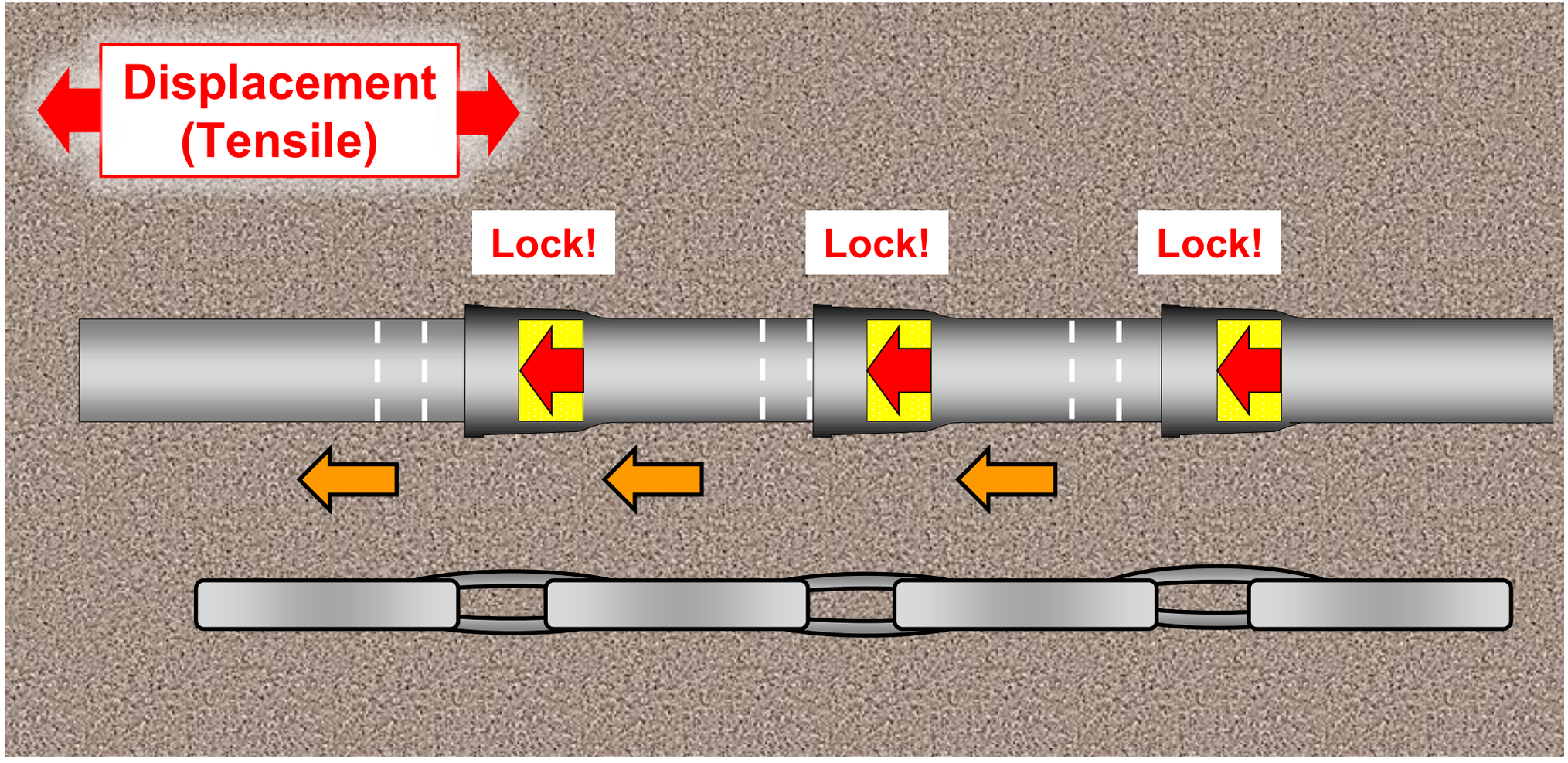
* D: nominal pipe size in millimeters

e.g. Size 100 mm pipe

-> Slip-out resistance is 3 x 100 = 300kN.

Note: Fitting joint has the same slip-out resistance as pipe joint.

Image of Slip-out resistance force



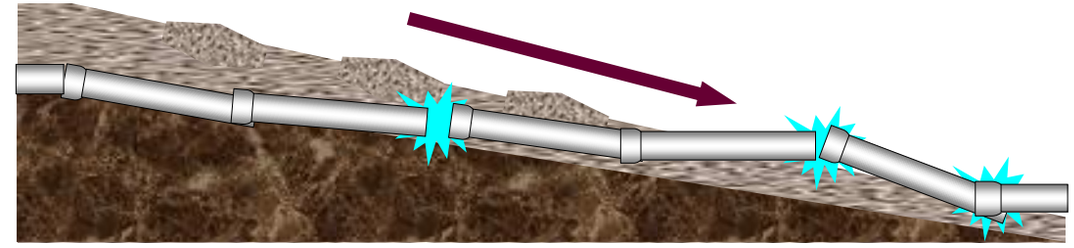
Joint Deflection Angle

Pipe size (mm)	80-400	450-1000	1100-1500	1600-2200	2400-2600
Max. Joint Deflection Angle	8°	7°	5°30’	4°	3°30’

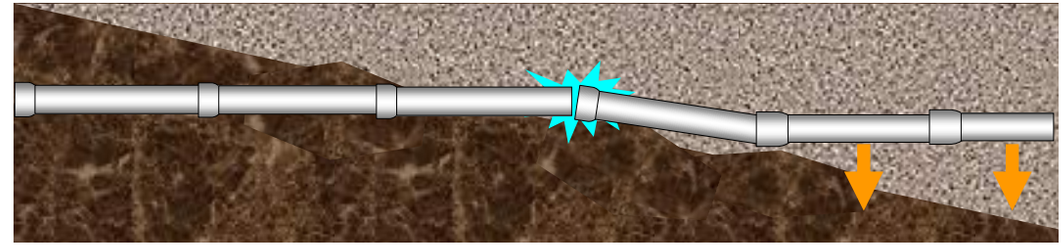
Lift-up Demonstration of 300mm

1) Weak Points in Pipeline

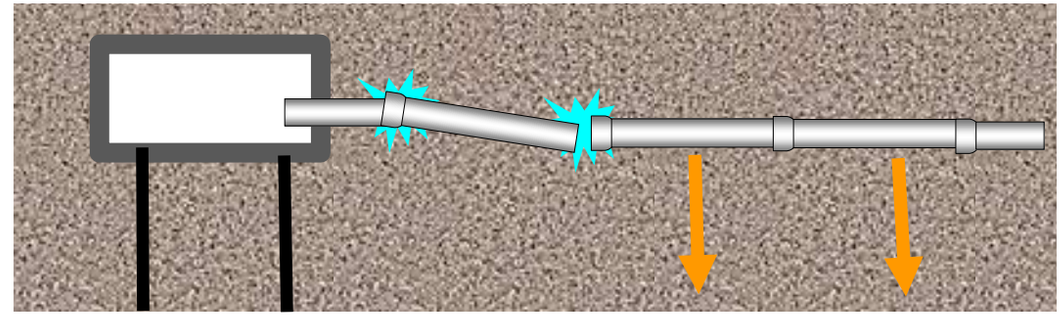
Slope
(ground deformation)



Soft ground
Uneven ground
condition



Ground settlement
near structure or
chamber



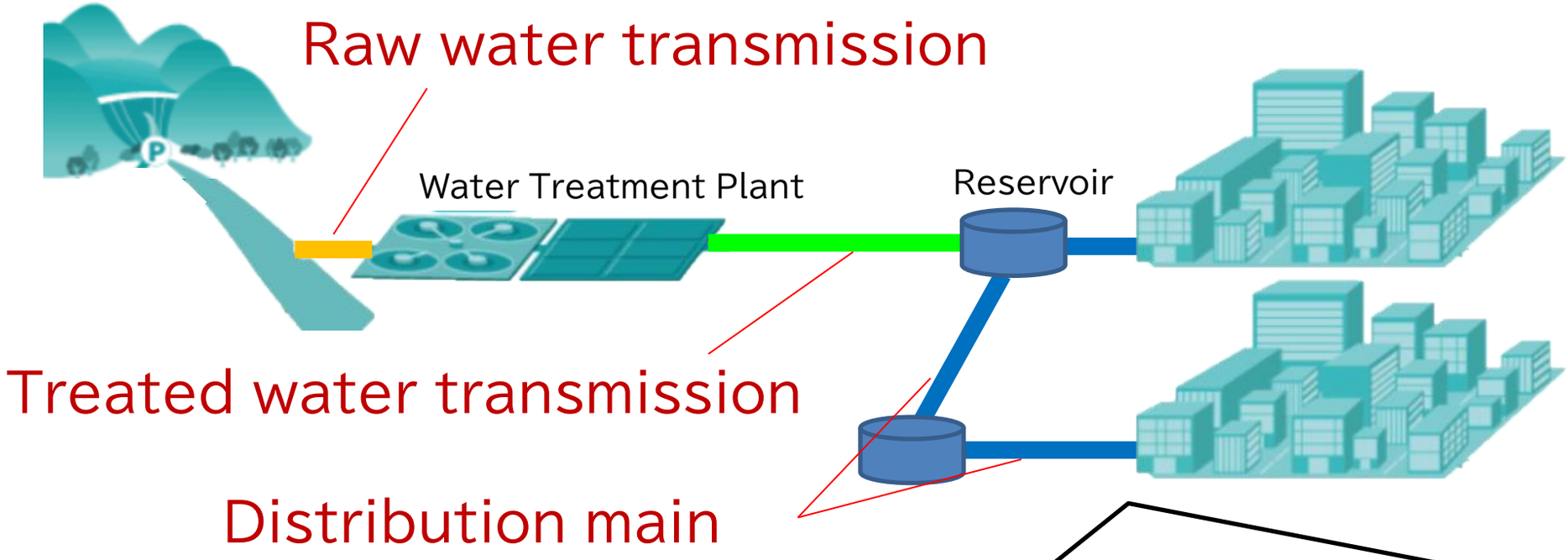
1) Weak Points in Pipeline

- Type: NS type
- Pipe size: 900mm

1) Weak Points in Pipeline (Southern California, USA)

- For Fault crossing
- Type: S-type
- Pipe size: 2600mm

2) Mains and Critical areas



- Pipes to essential infrastructures for human life and livelihood
  e.g. hospitals, evacuation centers, schools, transportation system, government office, city hall, fire hydrant, etc.
- Places where recovery work will be difficult in an accident
  e.g. populated areas, busy trunk roads, river crossings, etc.

2) Mains and Critical areas (Santa Clara, USA)

- For Fault crossing
- Type: S type
- Size: 1500, 1650, and 1800 mm

2) Mains and Critical areas (San Francisco, USA)

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- For Fire hydrant pipe
- Type: GX type and NS type
- Size: 200 to 600 mm

Contents

Supply Record: Singapore

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- Issue: Water Leakage on the taxi way in Changi Airport
- Type: GX type
- Size: 300 and 350mm

Supply Record: Canada

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- Issue: Soft ground
- Type: GX type and NS type
- Size: 150 to 900 mm

Supply Record: Nepal (ODA)

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- Issue: Earthquake
- Type: GX type
- Size: 75 to 150 mm
- Total length: 20 km

Summary

- HRDIP can withstand not only earthquakes but also other natural disasters, such as tsunamis and landslides.
- HRDIP can expand, contract, and deflect, and it has a great slip-out resistance.
- Kubota provides technical support, including planning, design, and on-site training.

Thank you
ありがとうございました。

Contact:
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