Replacement of Ductile Iron Pipes in Early Days

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What is Early Ductile Iron Pipe?



Early Ductile Iron Pipes

- Most special fittings are made of conventional cast-iron with lower strength and lower earthquake-resistance.
- No restraining function belongs to the joint.
- No mortar lining for corrosion-proof has been executed inside for several years since the beginning.
- No polyethylene sleeve for corrosion-proof.

Total Length of Distribution Pipes Managed in Tokyo Waterworks

Kind		Mains (\$400 - 2700) (km)	Sub-mains (φ50 - 350) (km)	Total (km)		Proportion (%)	
Aged Pipes	Cast-iron Pipes	30	197	227	244	0.9	1.0
	Steel Pipes	14	3	17	244	0.1	
Early Ductile Iron Pipes		163	2,485	2,648		10.3	
Ductile Iron Pipes		1,871	20,527	22,398		87.3	
Steel Pipes		227	122	349		1.4	
Others		0	13	13			0.1
Total		2,305	23,347	25	5,652	100	

Contents of Investigations *1. Pipe Condition Investigation* - Outside: Materials & Type of Joints Condition of Corrosion on Pipes & Bolts Depth of Corrosion (Pitting) Pipe Thickness, etc. - Inside: Neutralized Mortar Lining Thickness

Scale Thickness (Clogging Rate), etc.

2. Soil Investigation

- Field Survey: Evaluation Items for Corrosive Soil by ANSI Specific Resistance, pH, Redox Potential, Moisture & Sulfide
- Laboratory Test: Moisture Content, Sulfide Content, Chloride Ion Content, Sulfate Ion Content, Amount of Evaporated Residue & Specific Resistance of Extracted Water

Result of Pipe Condition Investigation



Straight Pipe \$\$\phi150\$
Maximum Depth of Pitting: 8.2mm (Bored through) *Condition of Corrosion (Pitting) outside Pipes*

Result of Pipe Condition Investigation



Corroding Condition of Bolts

Result of Pipe Condition Investigation



Sticking Condition of Scale inside a Pipe



Flow for Diagnosis of Corrosion Rate



Establishment of Degradation Rate Rank



No Particular Countermeasure

Result of Calculation of Laid Years which Come up to Respective Ranks



Diameter	Grou	ind I	Ground II		
(mm)	Rank IV	Rank V	Rank IV	Rank V	
75 - 400	48 years	65 years	39 years	52 years	
500 and over	over 65 years	over 82 years	over 52 years	over 67 years	

Evaluation of the Investigations and the Result of Analyses

Evaluation of Early Ductile Iron Pipes

- Earthquake Resistance for the joints and special fittings is low.
- The corroding bolts tend to break in earthquakes and so on.
 Ground II area has much possibility of liquefactions with a risk of damage even in small earthquakes.
- Ground II area where the external corrosion deteriorates rapidly, has much possibility of water leakage for thin pipes of under $\phi 400$ diameter.
- The neutralization of mortar lining and scale inside pipes cause water quality degrading, rusty water and decrease of flow capacity.

Implementation Policy of Replacement

Priority of Replacement

- 1. Important routes* & other routes in Ground II
- (1) Older routes which have more possibility of water leakage
- (2) The others

*Important routes:

- i) Forming the framework of pipeline network
- ii) Supplying water to such important facilities in earthquakes as emergency water tanks, places of refuge and medical institutions
- 2. The rest of early ductile iron pipelines

1. Joints The Effects of Replacement

Restraint fittings

The slipping off can be prevented and the functions of pipelines are maintained even in earthquakes "Earthquake-proof Joint"

2. Pipe Bodies

Ductile iron pipes with mortar lining and polyethylene sleeves

- All the pipes become stronger
- ➡ The corrosion-proofing can secure the thickness of pipes and the strength of bolts sustainably







Conclusion

-Our investigations have clarified such issues concerned with pipelines of Tokyo waterworks as early ductile iron pipes
-Our analyses helped to make the plan for replacement project of pipelines

-Importance of "Investigations and diagnoses of water distribution systems"

-Contribution to the appropriate management of Tokyo waterworks

谢谢!

Thank you for your attention



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