The potential of a new drainage system with special resin fittings for multiple water-saving toilet units in commercial buildings

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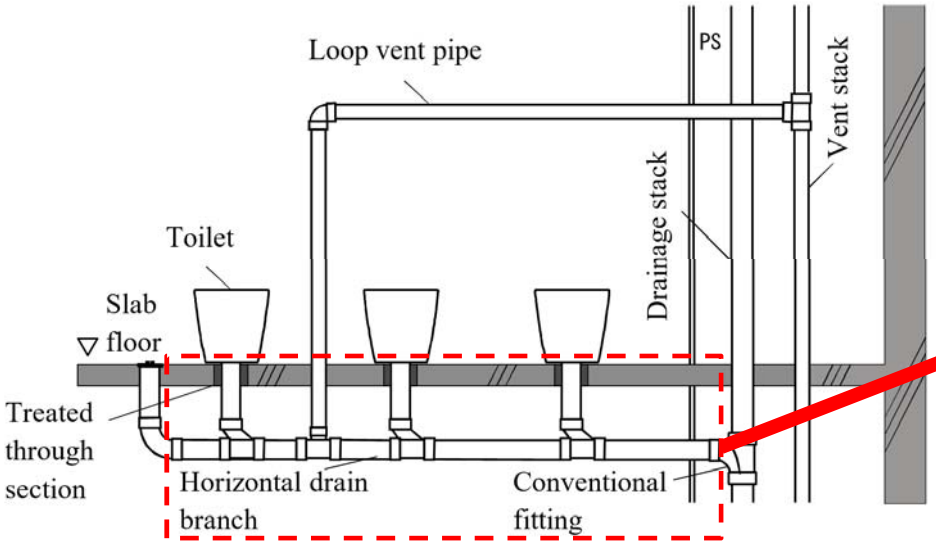
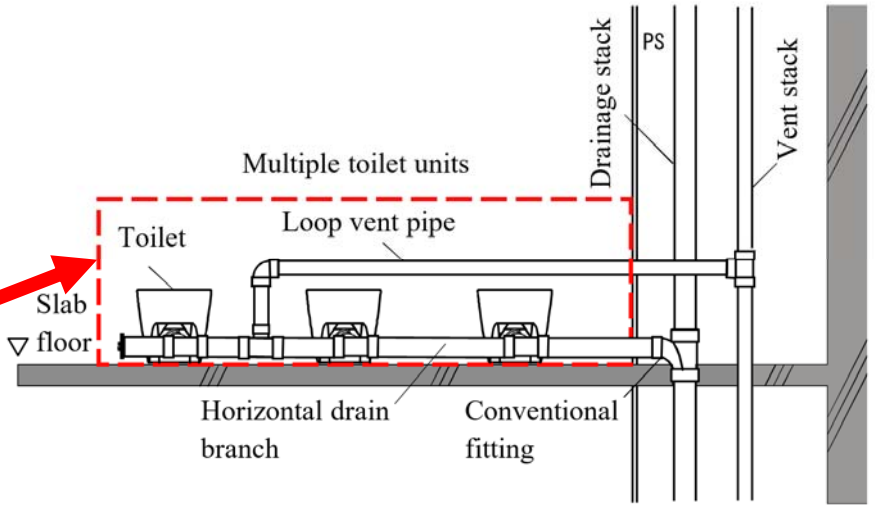
Comparison of two different horizontal drain branch arrangements with multiple toilets



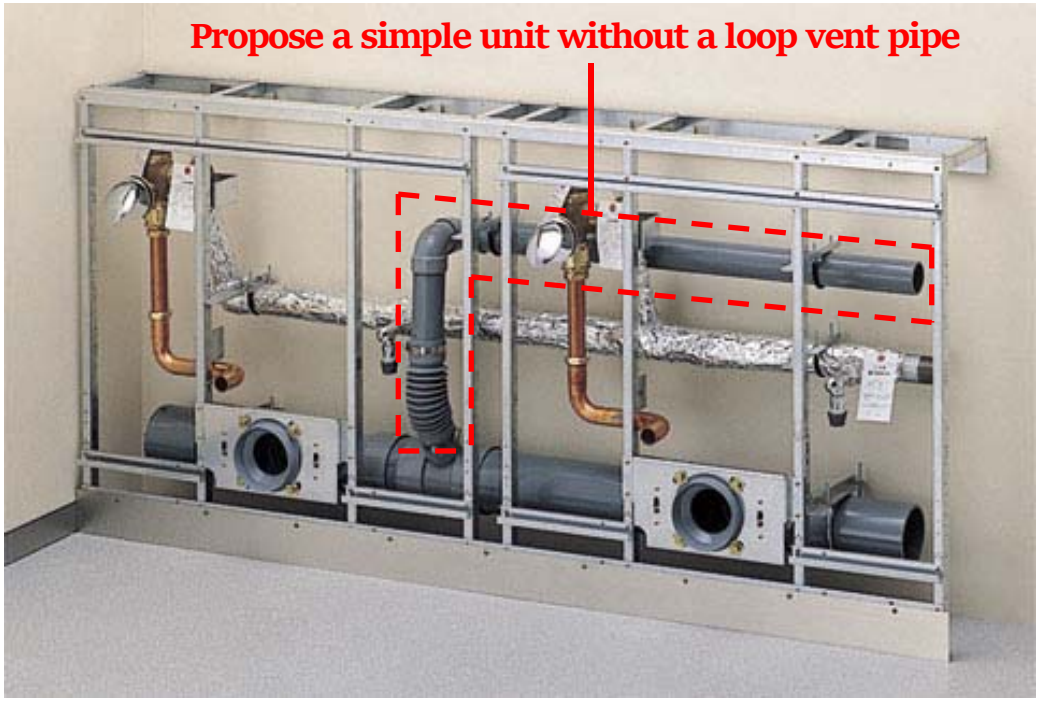
Under-slab-floor plumbing
(with conventionally arranged toilet units)



Above-slab-floor plumbing
(with sequentially arranged toilet units)

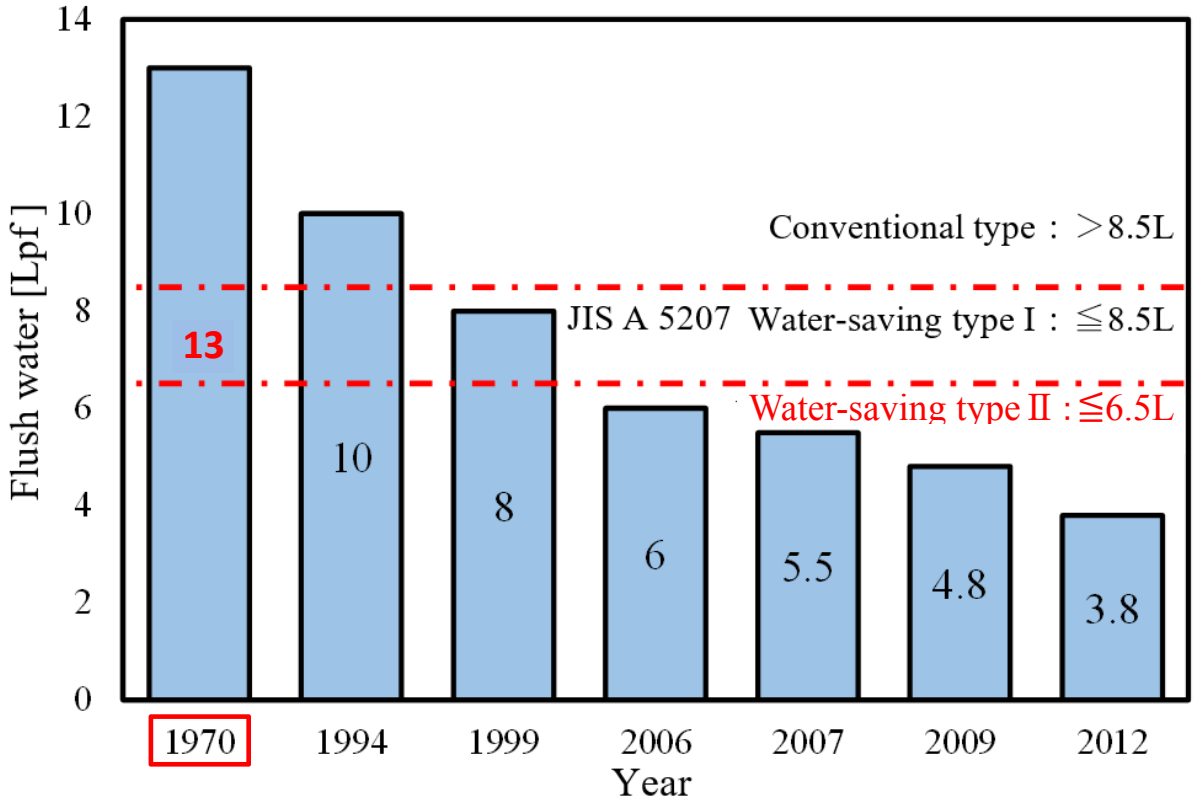
Multiple toilet units for business-related office space

Multiple toilet units



Plumbing

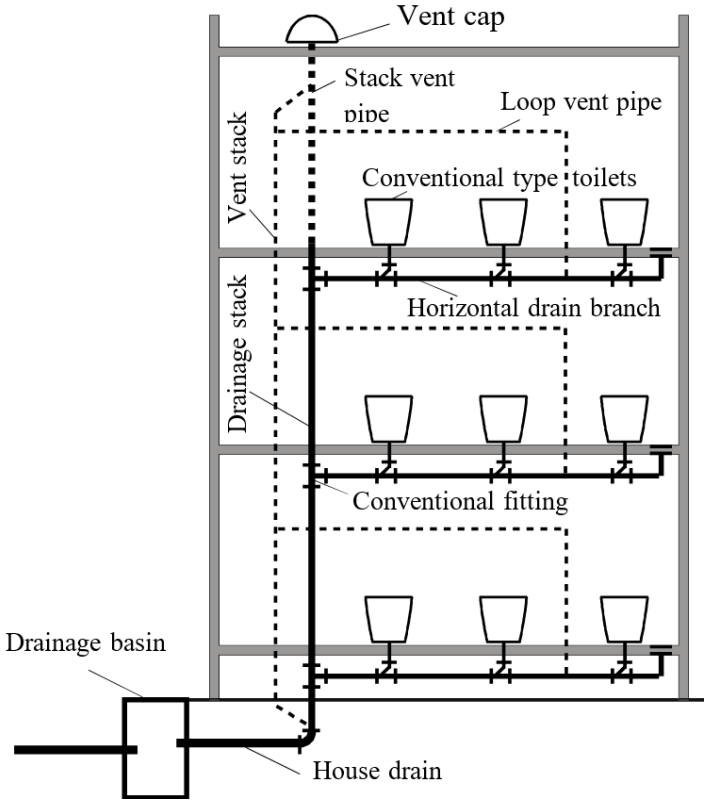
Water-saving trends with toilets in Japan from 1970 to present-day



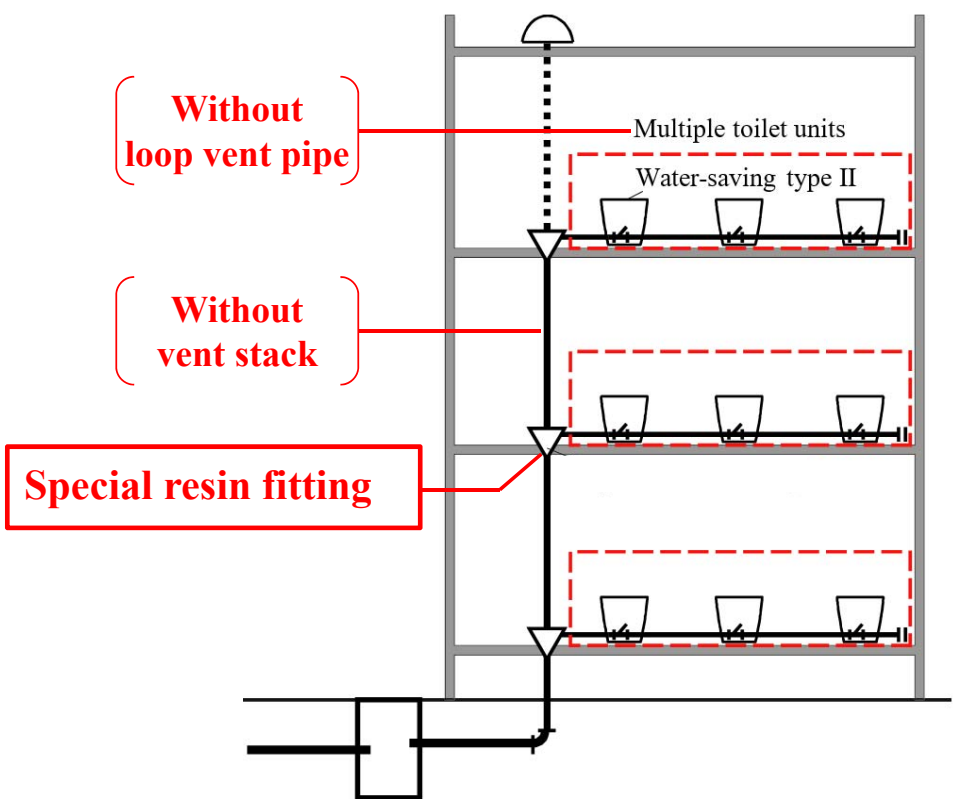
Transition of water-saving trends with toilets

Conventional drainage system and special fitting drainage system for multiple water-saving toilet units in high-rise buildings

ge system
tem)



Conventional drainage system (loop vent system)



Special fitting drainage system (for multiple water-saving toilet units)

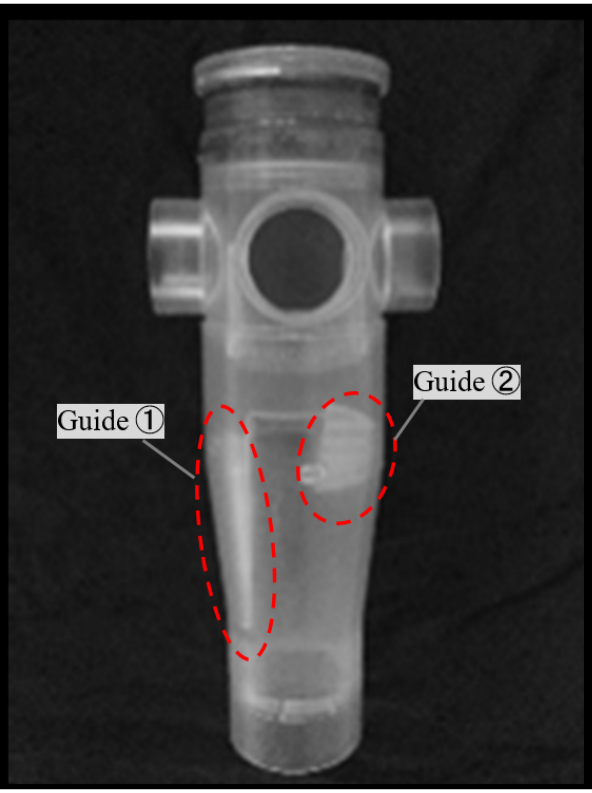
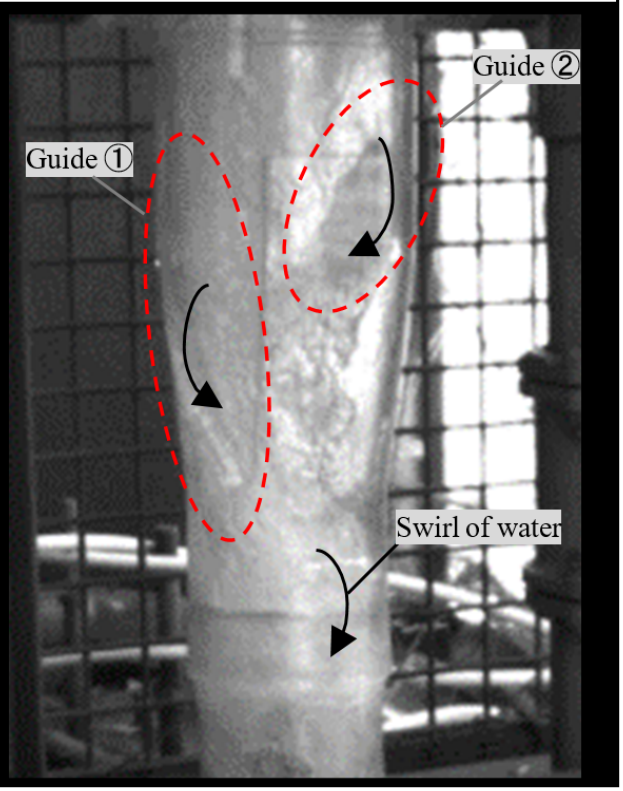
In this report, we will clarify the following points:

(1) **Propose and give an overview of a drainage system with special resin fittings compatible with multiple water-saving toilet units in business- related buildings**

(2) **Share our understanding of the drainage loads generated by multiple water-saving toilet units**

(3) **Examine and discuss the influence of drainage loads on the drainage capacity of a drainage stack system and verify the effectiveness of the proposed system**

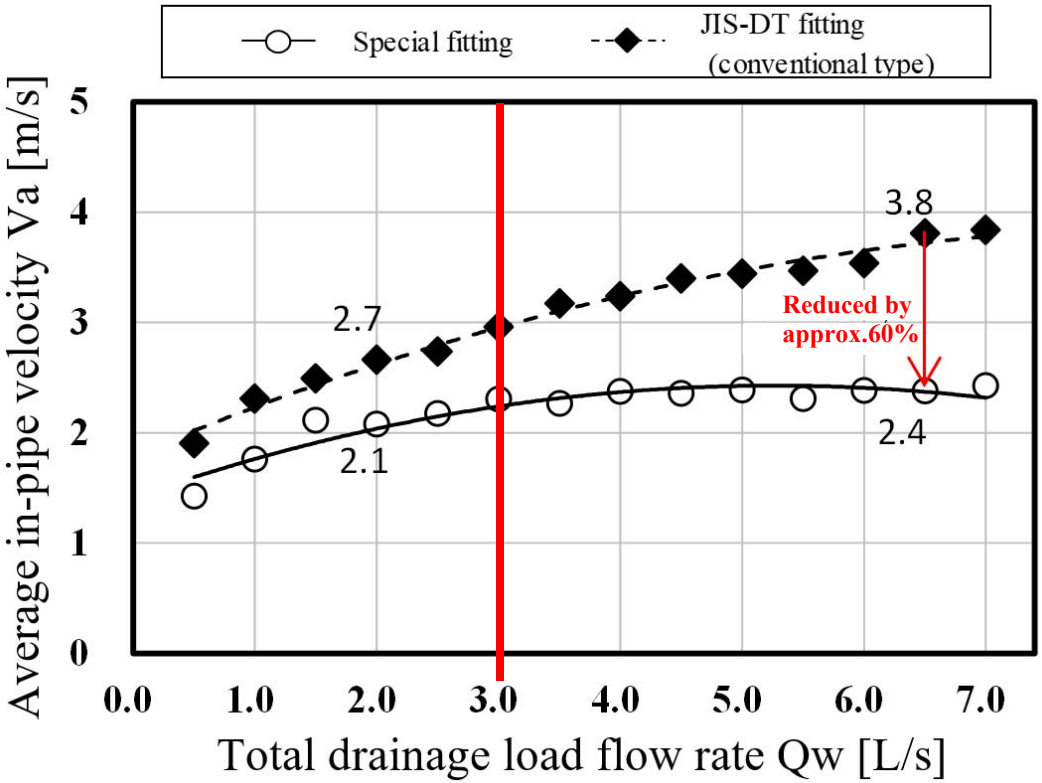
Special fittings

Cast-iron fitting	Resin fitting	The flow of water when drained
		

2. Proposal and overview of a drainage system with special resin fittings compatible with multiple water-saving toilet units

Relationship between the drainage load flow rate and the average velocity in a stack vent pipe index of water flow with a JIS-DT fitting and one with a special resin fitting.

The average velocity hardly increases after the drainage load flow rate reaches 3.0L/s, and even when the drainage load flow rate is 6.5L/s, the average velocity is still 2.4m/s.



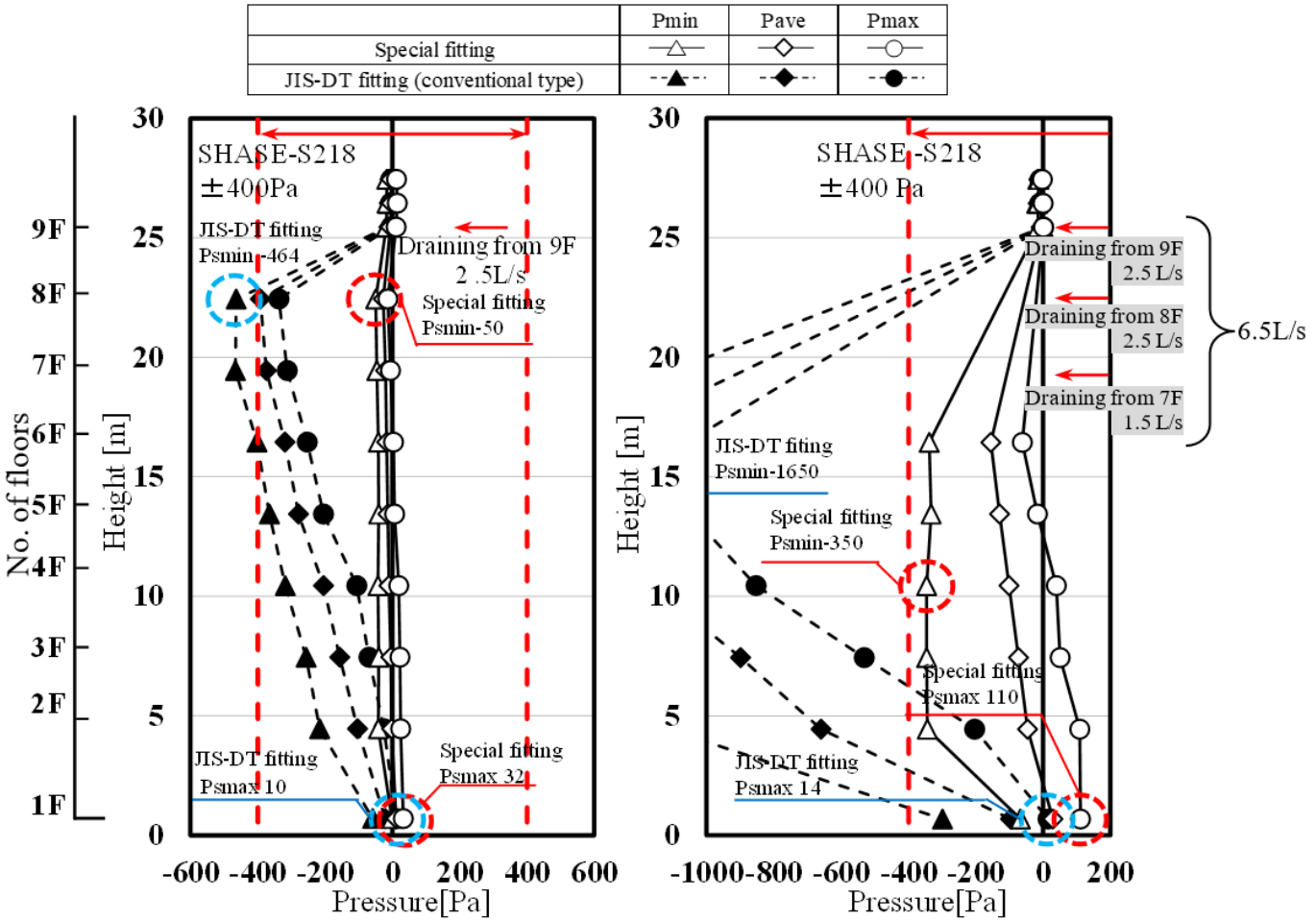
Total constant flow drainage load flow rate Qw and average in-pipe velocity Va

2. Proposal and overview of a drainage system with special resin fittings compatible with multiple water-saving toilet units

Two distributions of in-pipe pressure values.

Experiments were conducted according to the Testing Methods of Flow Capacity for Drainage System in Apartment Houses specified by SHASE-S218.

Graphs show that the variation of in-pipe pressure is reduced significantly by use of the special resin fitting.



2.5[L/s] per drainage | 6.5[L/s] per drainage

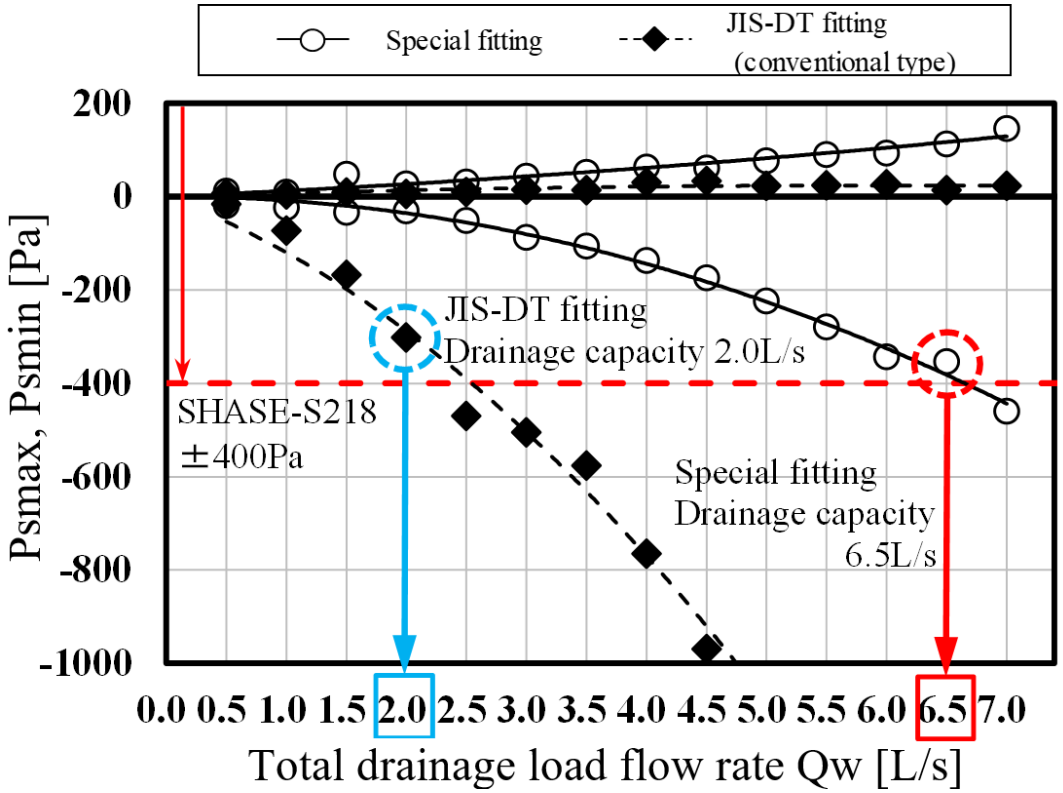
Distributions of pressure by applied constant flow drainage loads

2. Proposal and overview of a drainage system with special resin fittings compatible with multiple water-saving toilet units

Reference value is (±400Pa) as specified by SHASE-S218.

Conventional fitting: drainage capacity is 2.0L/s

Special resin fitting: drainage capacity is 6.5L/s, indicating a 3.25 times increase.



Total drainage load flow rate Qw in relation to maximum system value Psmax and minimum system value Psmin

2. Proposal and overview of a drainage system with special resin fittings compatible with multiple water-saving toilet units

Characteristics of the Special Resin Fitting

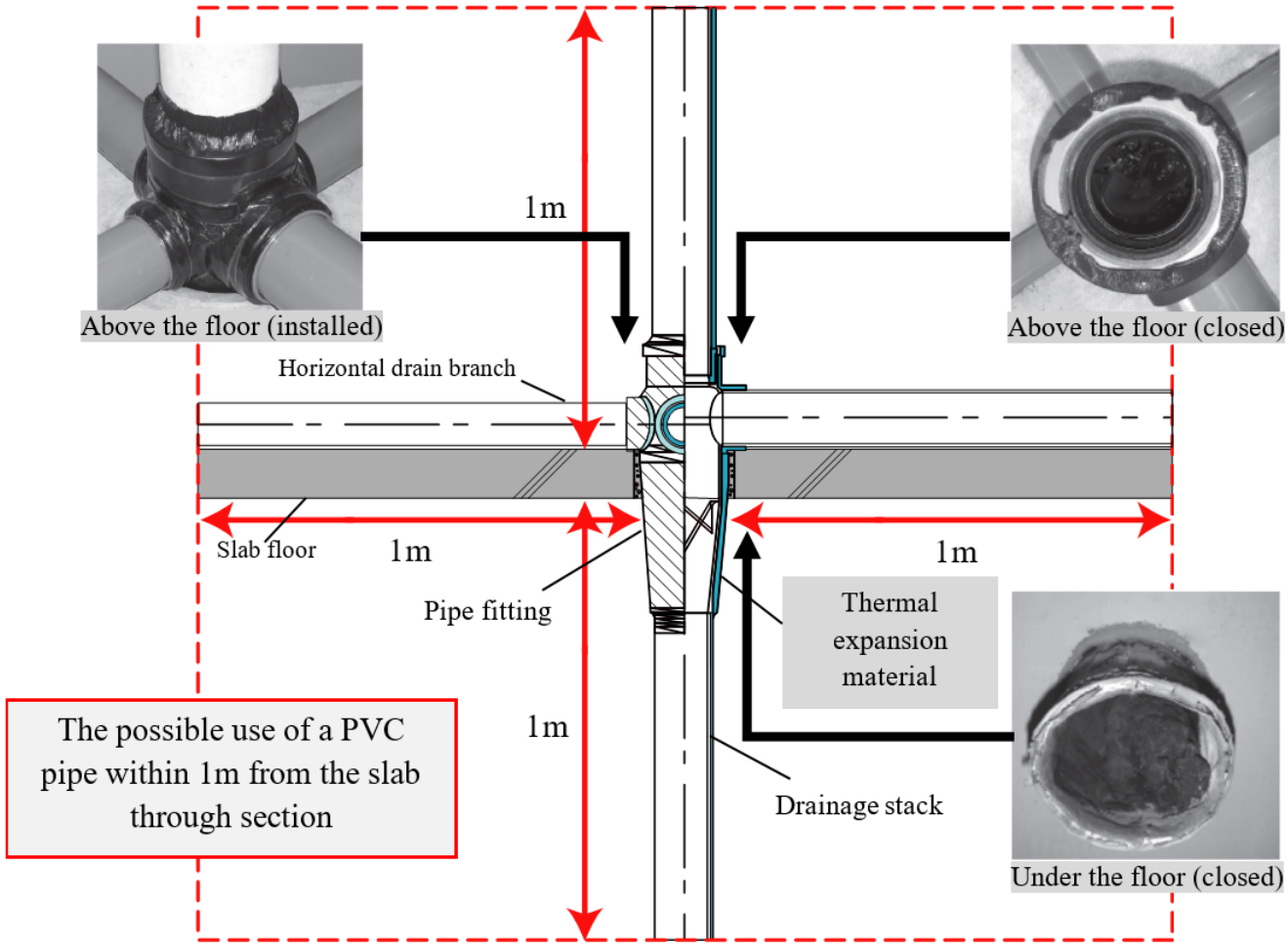
-Fire resistant resin-

Expands to close the pipeline in the event of a fire

Prevents flames and smoke from entering the drainage system

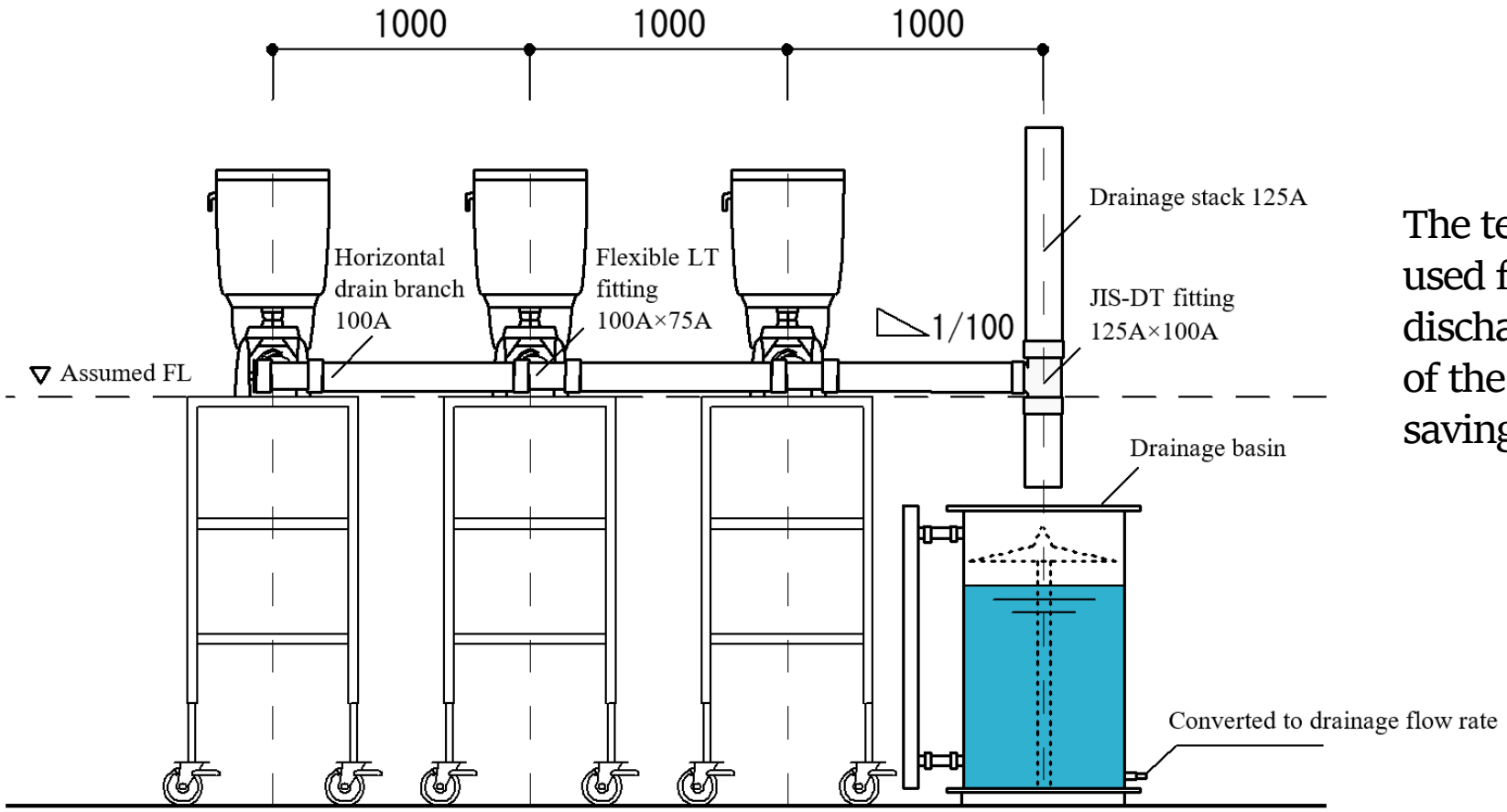
Minimizes the spread of fire in the drainage system

Minimizes the noise of wastewater flowing through the pipes



Fire resistance of the special fitting

3. Understanding of the drainage loads generated by multiple water-saving toilet units



Fixture discharge characteristics testing apparatus (SHASE-S220)

The testing apparatus used for measuring the discharge characteristics of the experimental water-saving toilets.

Measured Values:

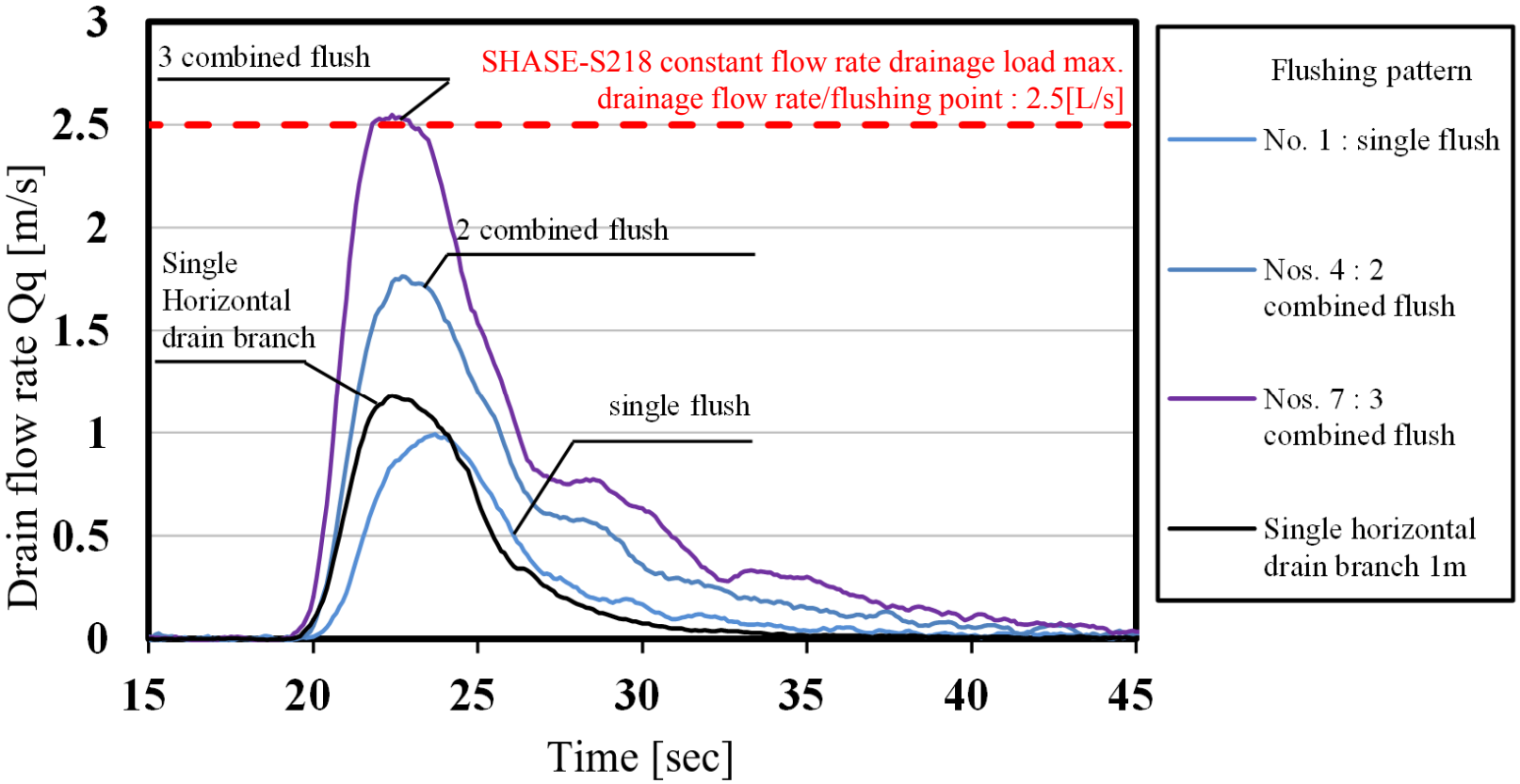
Discharge characteristics of experimental water-saving toilets

Flushing pattern	Flushing point ①	Flushing point ②	Flushing point ③	Amount of flushed water w[L]	Average drain time td′[s]	Average drainage flow rate qd′[L/s]	Max. drainage flow rate qmax[L/s]
No.1	●			6.0	6.0	0.60	0.99
No.2		●		6.0	8.2	0.44	0.93
No.3			●	6.0	9.6	0.38	0.94
No.4	●	●		12.1	7.2	1.01	1.76
No.5	●		●	12.0	6.7	1.07	1.87
No.6		●	●	12.1	8.0	0.90	1.83
No.7	●	●	●	18.0	8.0	1.35	2.55

※ Single flush (horizontal drain branch length 1m) w: 6.0L/s td': 4.0s qd': 0.91L/s qmax: 1.19L/s

When three toilets were flushed simultaneously (flushing pattern No. 7), the average drainage flow rate, qd', was measured to be 1.35L/s, and the maximum drainage flow rate, qmax, was measured to be 2.55L/s, which is considered roughly the same as the drainage load flow rate of 2.5L/s measured in one horizontal drain branch according to SHASE-S218.

Measured Values:

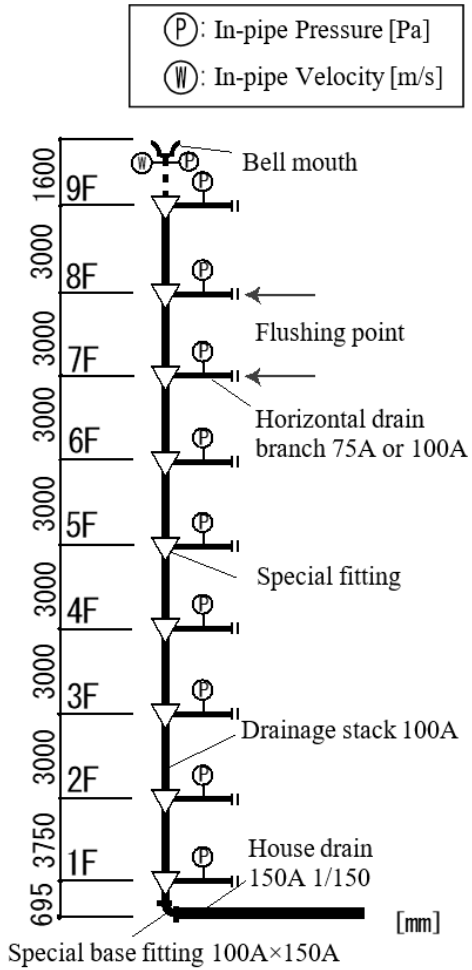


Flow rates of water drained from experimental multiple water-saving toilets

4. Understanding of the influence of drainage loads on the drainage capacity of a drainage stack system and the verification of the effectiveness of the proposed system

(1) Discussion on the in-pipe pressure distributions

Experimental tower (Kanto Gakuin University)



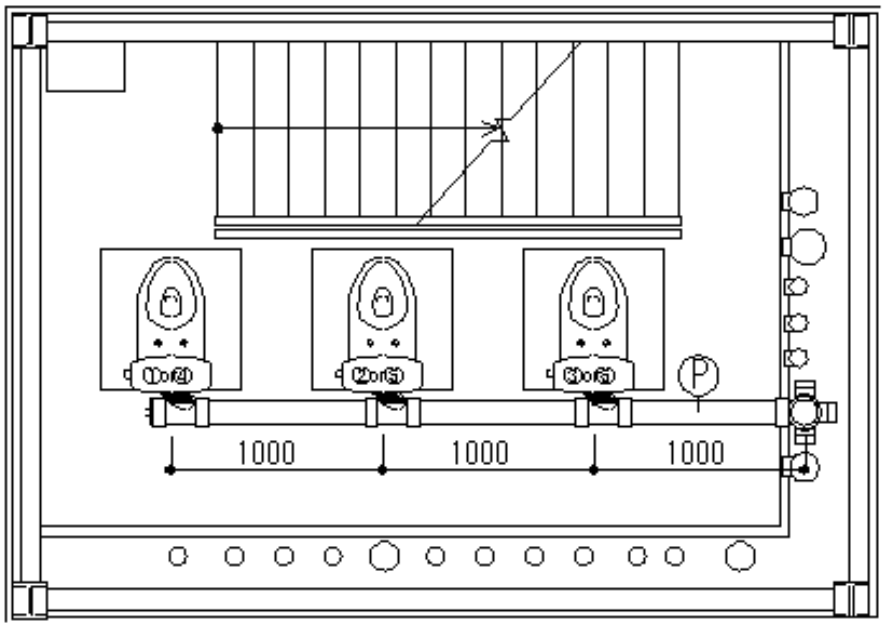
Experimental drainage stack system

Experiment Laboratory:

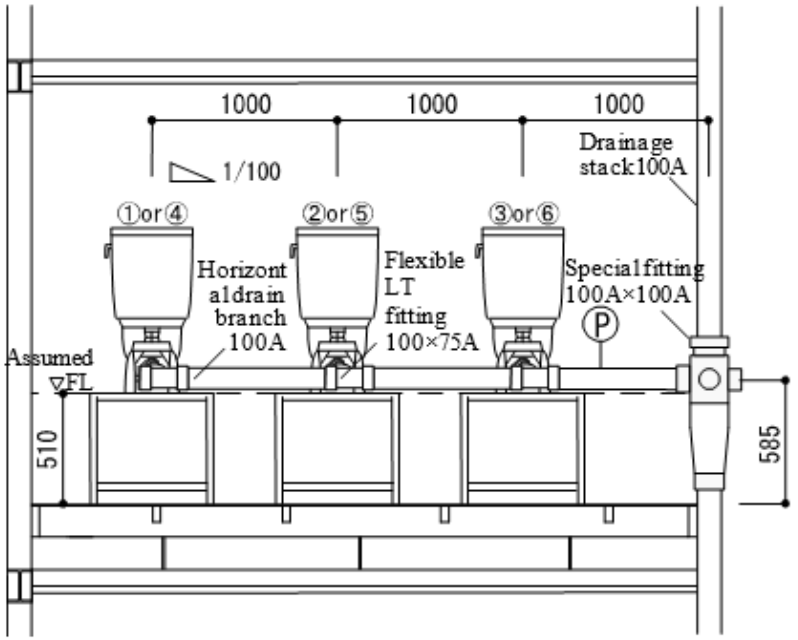
9-floor tower with a drainage stack system
(Kanto Gakuin University, Mutsuura Campus in Yokohama Japan)

4. Understanding of the influence of drainage loads on the drainage capacity of a drainage stack system and the verification of the effectiveness of the proposed system

(1) Discussion on the in-pipe pressure distributions



8F and 7F - plane view



8F and 7F - elevation view

Experimental horizontal drain branch system (installed on 8F and 7F)

4. Understanding of the influence of drainage loads on the drainage capacity of a drainage stack system and the verification of the effectiveness of the proposed system

Drainage load patterns

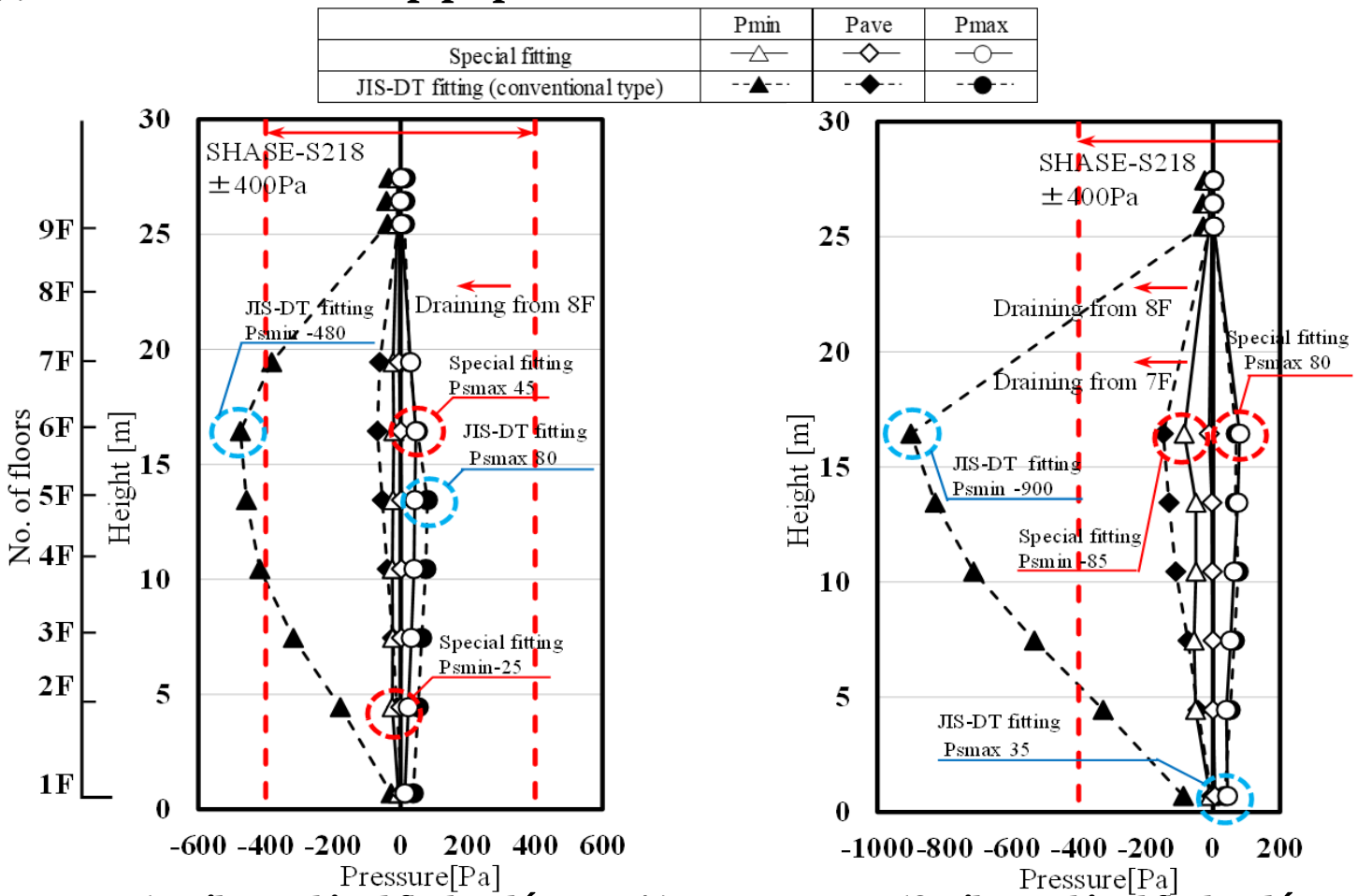
Drainage load pattern			No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12
Flushing point	Multiple toilets on 8F	①	●			●	●		●	●	●	●	●	●
		②		●		●		●	●		●	●	●	●
		③			●		●	●	●			●	●	●
	Multiple toilets on 7F	④								●	●	●	●	●
		⑤									●		●	●
		⑥												●
Total average drainage load flow rate		Σqd'[L/s]	0.9	0.9	0.9	1.8	1.8	1.8	2.7	1.8	3.6	3.6	4.5	5.4

Combined flushing of three toilet units from the 8th floor
(Σqd´ = 2.7L/s)

Combined flushing of six toilet units from the 7th and 8th floors
(Σqd´ = 5.4L/s)

4. Understanding of the influence of drainage loads on the drainage capacity of a drainage stack system and the verification of the effectiveness of the proposed system

(1) Discussion on the in-pipe pressure distributions



No.7 (3-toilet combined flushΣqd´=2.7L/s)

No.12 (6-toilet combined flushΣqd´=5.4L/s)

Distribution of pressure by applied drainage loads

No. 7:

★ Pmin exceeds the reference value of -400Pa when the conventional fitting is used; approximately -480Pa on the 6th floor,

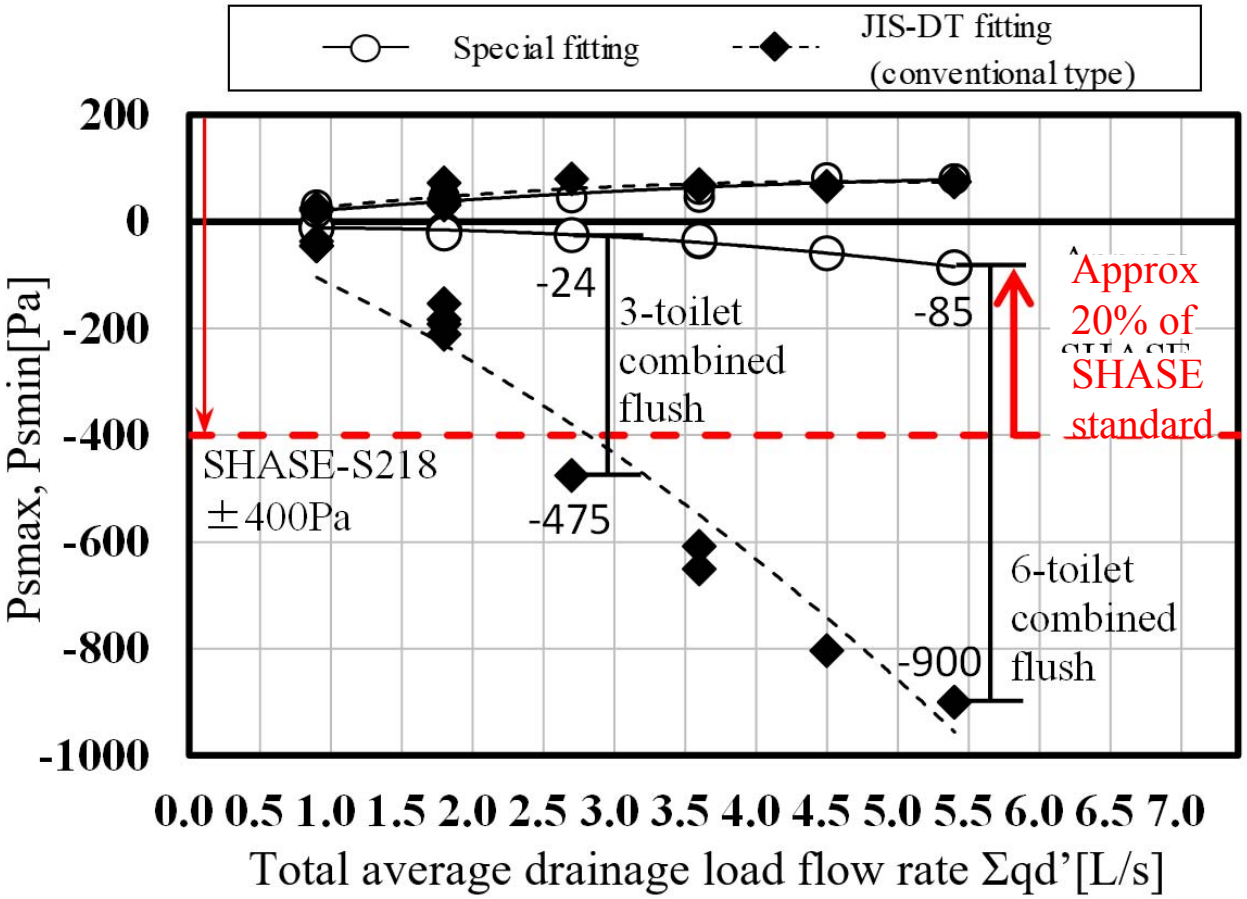
★ Pmin does not change greatly on the 2nd to 6th floors with the special resin fitting; approximately -25Pa on each floor, approximately 95% less than the conventional fitting.

No.12:

★ Pmin is approximately -900Pa on the 6th floor when the conventional fitting is used, but -85Pa when with the special resin fitting, about 90% less than that of the conventional fitting.

4. Understanding of the influence of drainage loads on the drainage capacity of a drainage stack system and the verification of the effectiveness of the proposed system

(2) Discussion on the drainage capacity



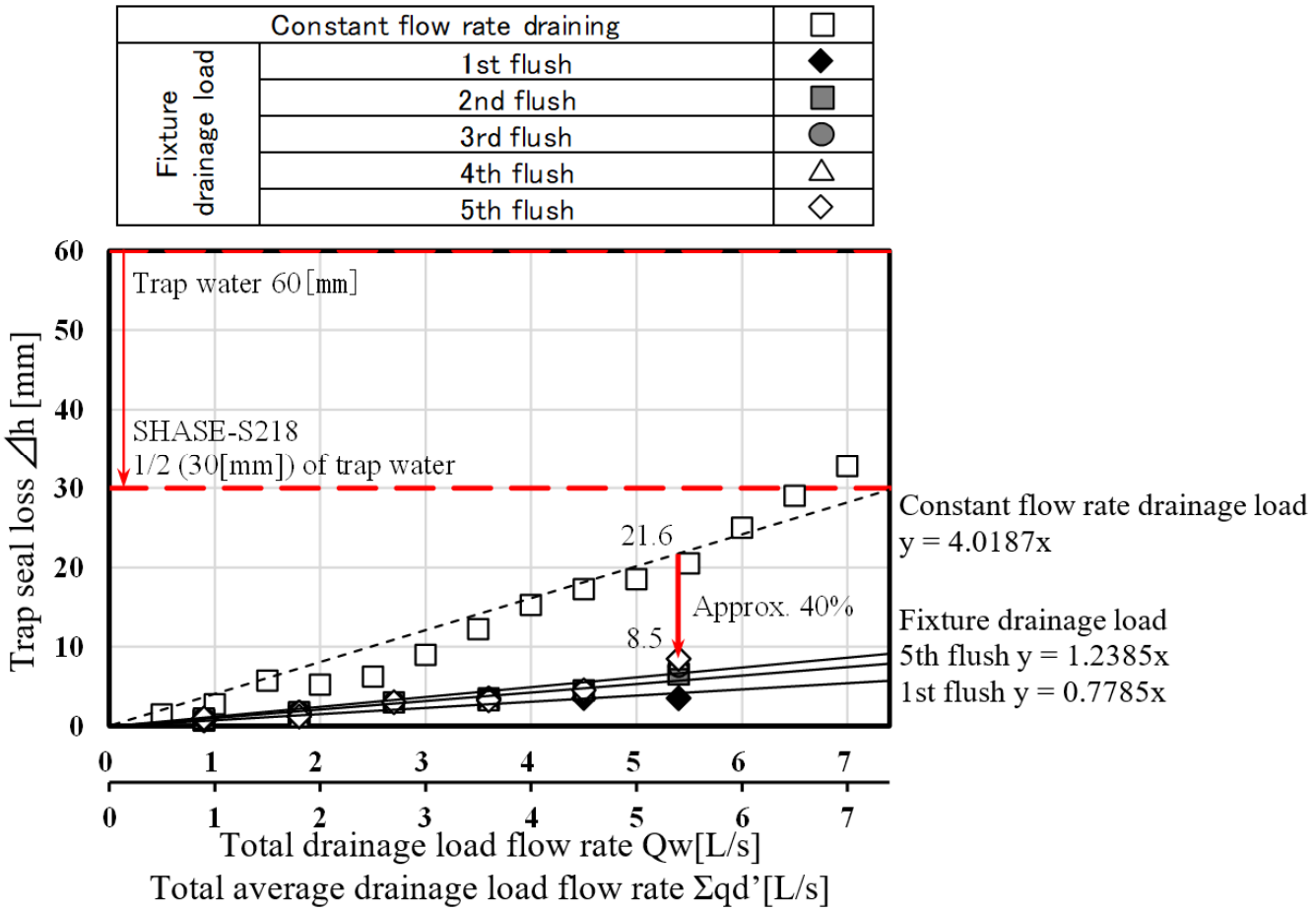
Total average drainage load flow rate Σqd' in relation to maximum system value Psmax and minimum system value Psmin

Flushing of three toilets simultaneously, Σqd´ was measured to be 2.7L/s, exceeding the reference value of SHASE-S218.

Flushing of the special resin fitting toilets (up to as many as six simultaneously), Σqd´ was measured to be 5.4L/s.
This amount only exceeded the reference value by a mere 20% or so.

4. Understanding of the influence of drainage loads on the drainage capacity of a drainage stack system and the verification of the effectiveness of the proposed system

(2) Discussion on the drainage capacity



Fixture drainage load caused approximately 40% trap seal loss.

With reference to the variation of in-pipe pressure and the trap seal loss as indices,
the proposed drainage system has an adequate drainage capacity.

5. Conclusions

(1) Using SHASE-S218 definitions, we confirmed special resin fittings ensure a drainage capacity approximately 2.5 times larger than that of conventional fittings. Increased drainage capacity is considered related to reduced flow velocity in the pipe.

(2) Maximum drainage load flow rate is approximately 2.5L/s, with the average fixture drainage flow rate less than 1.5L/s. SHASE-S218 specifications state maximum drainage load flow rate from the first floor to be 2.5L/s. Measured drainage load flow rates are within SHASE-S218 perimeters. Thus, SHASE-S218 is applicable to drainage systems for business-related buildings.

(3) With reference to the reference value specified by SHASE-S218; with the variation of in-pipe pressure (within ±400Pa) and trap seal loss (seal water depth: less than 1/2), it has been confirmed that our proposed drainage system is applicable to high-rise business-related buildings.

Otsuka Laboratory

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