

A study about the evaluation of the under-slab-floor drainage performance of a multiple water-saving toilet system comprising eight toilet units

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1. Background and objectives of the study

■ At the 42nd International Symposium of CIB W062 in Košice, Fixture discharge characteristics and carrying performance of a multiple water-saving toilet system comprising five 6.0L toilet units when the toilet units are plumbed on the slab floor.

■ With a focus on the case where a multiple water-saving toilet system comprising eight water-saving toilet units, and the horizontal fixture drain branch, to which said toilet units are connected, is installed underneath the slab floor, this report examines the fixture discharge characteristics of the system and how the fixture discharge characteristics affect the carrying performance, as well as examining the system's performance with or without a loop vent pipe.

- (1) Acquiring fixture discharge characteristic values
- (2) Identifying single-flush and combined-flush characteristics
- (3) Understanding the influence of using a loop vent pipe
- (4) Discussion on the amount of water for fixed-time-period flushing and flushing intervals

2. Experiment overview

2.1 Experimental horizontal fixture drain branch system

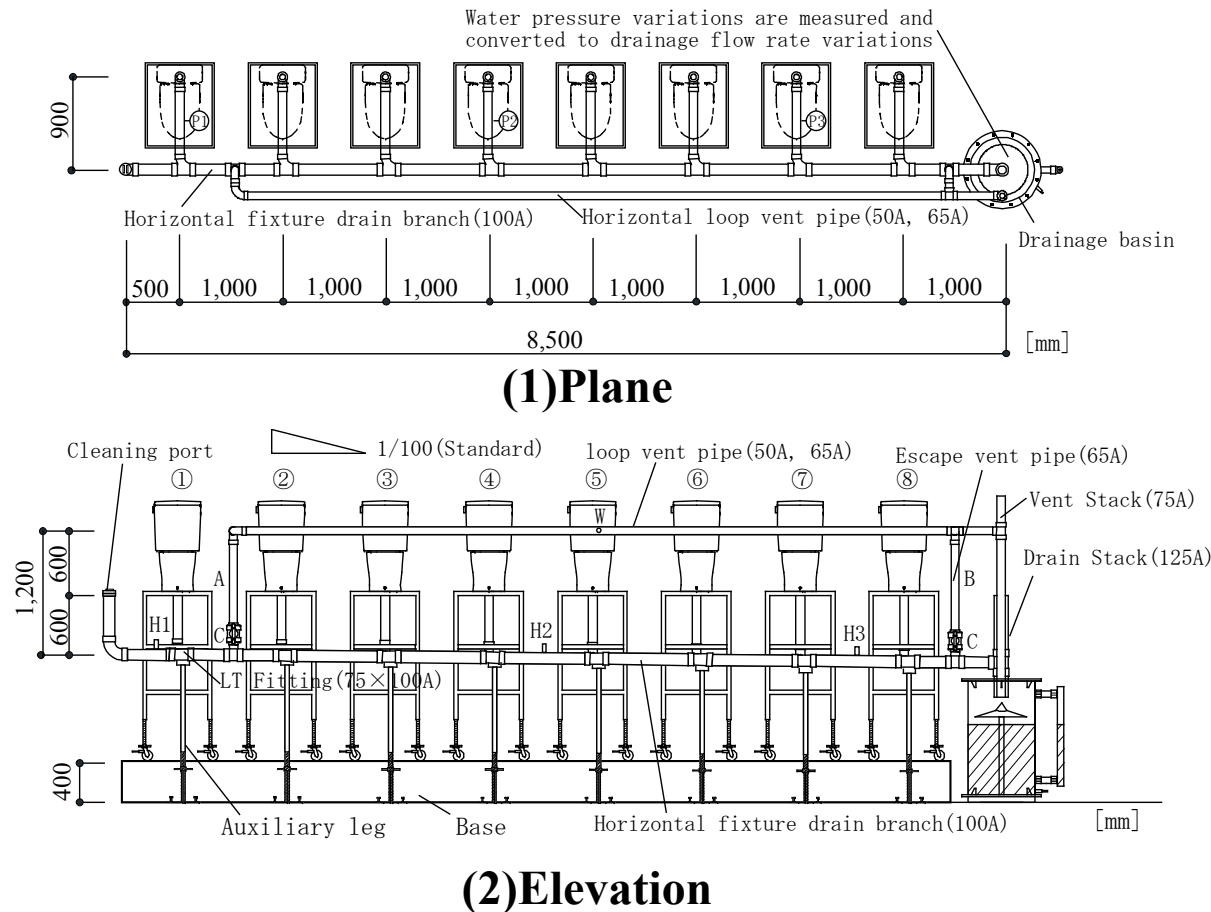


Fig.1 Experimental horizontal fixture drain branch system

■ The system simulates a series of toilet booths installed in an office building, i.e., eight experimental toilet units are sequentially connected to a horizontal fixture drain branch that is fixed under the slab floor.

2. Experiment overview

2.1 Experimental horizontal fixture drain branch system

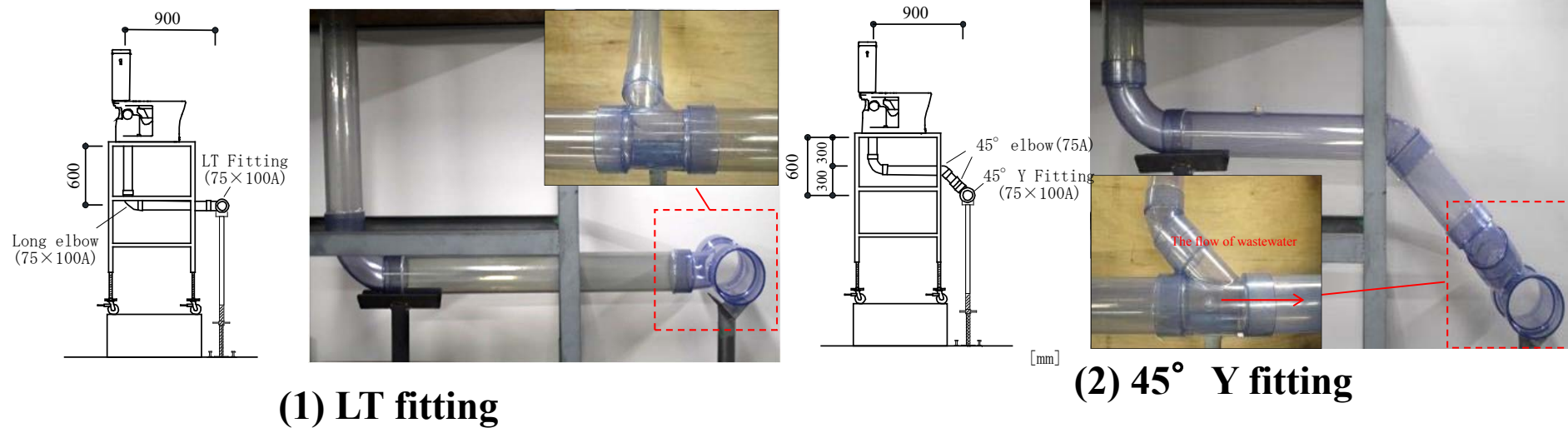


Fig. 2 Fittings used for connecting the horizontal fixture drain branch

■ the system comprises a drainpipe, which connects each experimental toilet unit and the horizontal fixture drain branch together, in two configurations, one with an **LT fitting to provide a 90° flow angle in the joint part** (hereinafter referred to as 'LT fitting') and the other with a **45° Y fitting and a 45° elbow to provide a 45° flow angle** (hereinafter referred to as '45° Y fitting').

2. Experiment overview

2.2 Fixture discharge characteristics experiment

$$\text{The average fixture discharge flow rate } qd' = \frac{0.6 \times W}{td} \quad \dots (1)$$

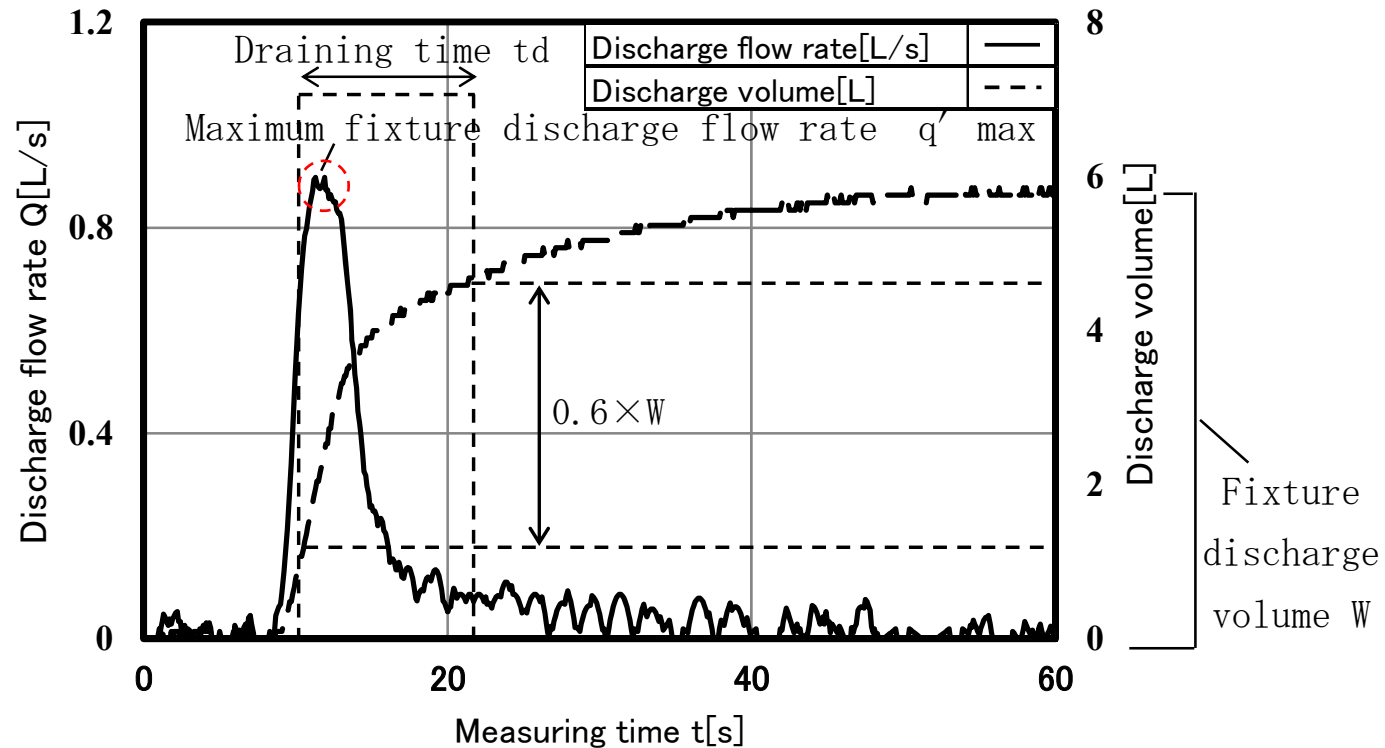



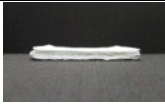
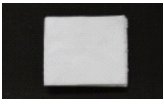

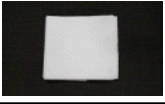

Fig.3 Fixture discharge volume/flow rate curve (example)

■ Fixture discharge characteristics are measured in accordance with SHASE-S220 when the experimental toilets are respectively flushed using clean water only.

2. Experiment overview

2.3 Single-flush / combined-flush carrying performance experiment

Table 1 Experimental waste substitutes

Type	Experimental waste substitute		Description
D			1-ply toilet paper, laid flat, 1m x 6 pieces
D'			2-ply toilet paper, laid flat, 1m x 6 pieces
BL *			1-ply toilet paper, laid flat, 0.9m x 4 pieces

* In accordance with Better Living BLE WC:2013

Table 2 Flushing patterns

(1) Single-flush

Flushing pattern		Toilet							
		(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Single flush	No.1	○							
	No.2		○						
	No.3			○					
	No.4				○				
	No.5					○			
	No.6						○		
	No.7							○	
	No.8								○

(2) Combined-flush

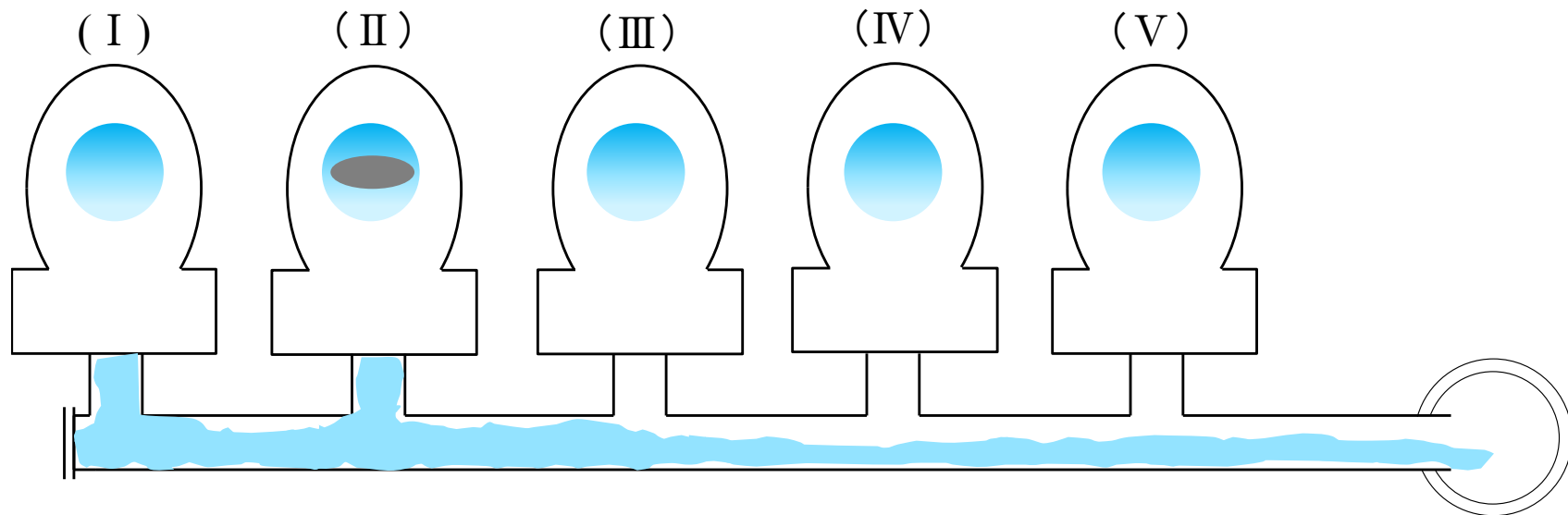
Flushing pattern		Toilet							
		(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Combined flush	No.9	○	○	○	○				
	No.10	○	○	○	○	○			
	No.11	○	○	○			○	○	○
	No.12	○	○	○	○	○	○	○	○

*○: Toilet(s) used for testing

2. Experiment overview

2.4 Fixed-time-period flushing experiment

■ In the case of a single-flush pattern that causes the shortest carrying distance, the most upstream toilet (I) is flushed, with clean water only, **1 hours** after the drained waste substitute stopped in the horizontal fixture drain branch, and the further carrying distance made by the fixed-time-period flushing is measured.



3. Result and discussions

3.1 Fixture discharge characteristics experiment

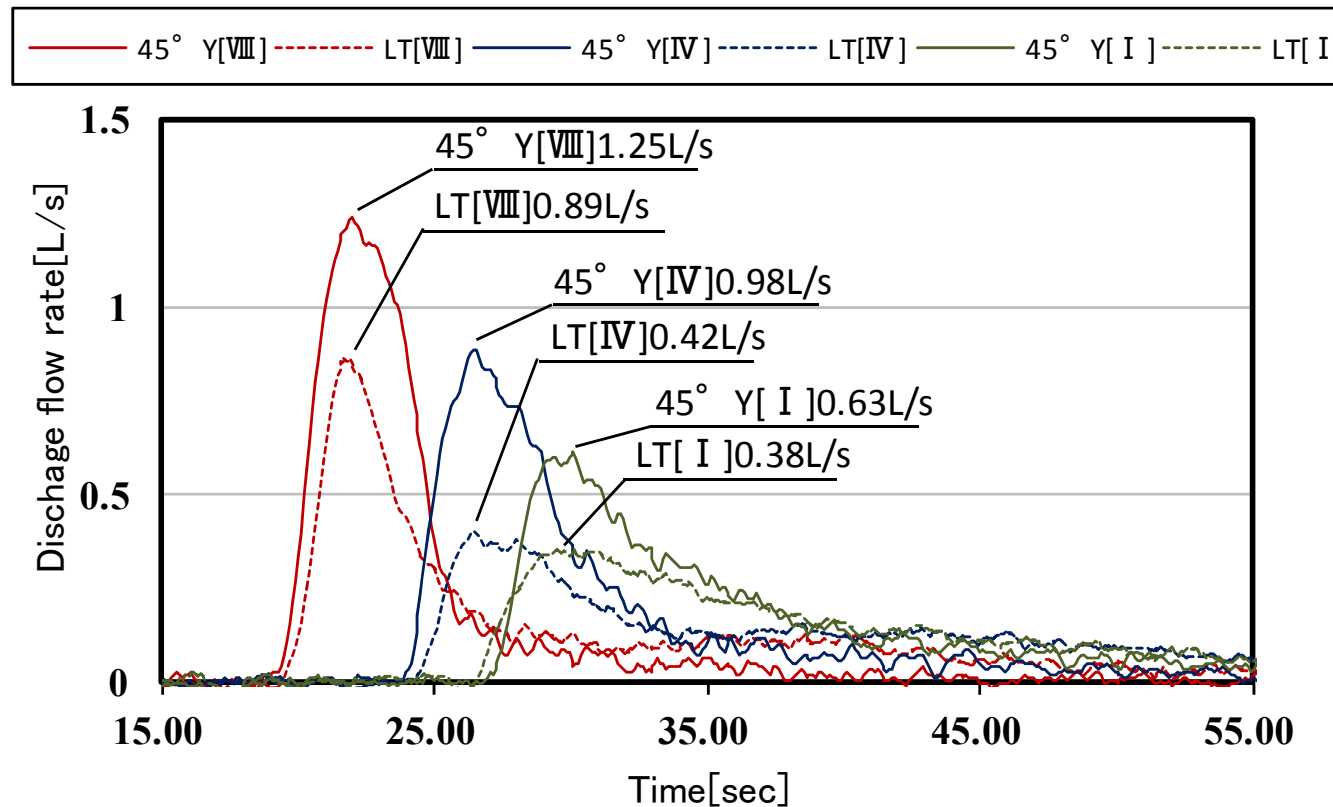


Fig. 4 Discharge flow rate curves compared by the shape of fitting

■ The maximum discharge flow rates are greater when using the 45° Y fitting than when using the LT fitting; by approximately 0.36L/s in the case of toilet unit (VIII), 0.56L/s in the case of toilet unit (IV), and approximately 0.25L/s in the case of toilet unit (I), i.e., by approximately 28.8-57% on the whole.

3. Result and discussions

3.1 Fixture discharge characteristics experiment

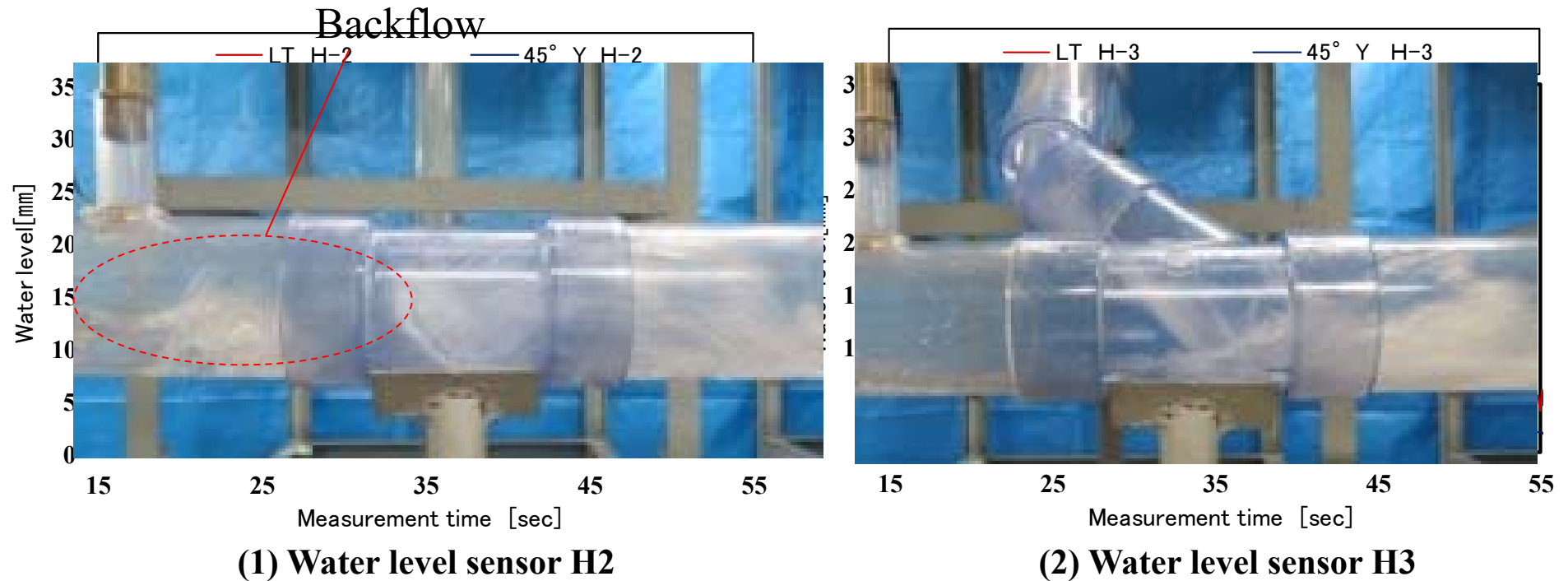


Fig. 5. Water level variations when flushing toilet (V)

- At H2, the water level was measured to be approximately 25mm at maximum when using the LT fitting, and approximately 8mm at maximum when using the 45° Y fitting.
- At H3, the LT fitting creates less resistance than the 45° Y fitting, and therefore, the water level was measured to be lower with the LT fitting than with the 45° Y fitting.
- The water is drained from the toilet unit at a higher water level when using the 45° Y fitting than when using the LT fitting.

3. Result and discussions

3.2 Carrying performance experiment

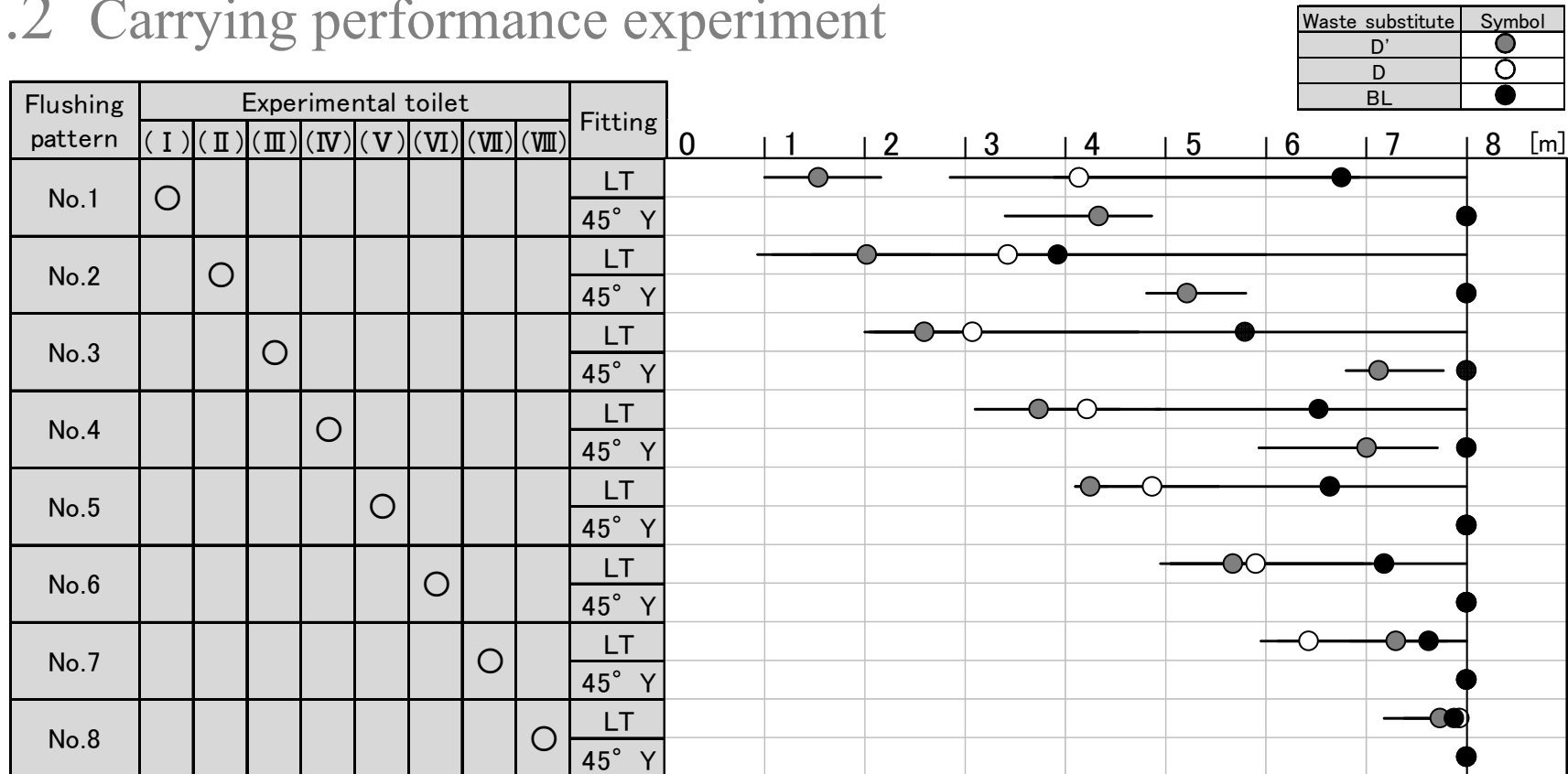


Fig. 6 Single-flush testing results

■ When using the 45° Y fitting, unlike with the LT fitting, waste substitutes D and BL, apart from D', were **completely drained through to the drainage stack.**

■ the distance it was carried in each pattern was longer when using the 45° Y fitting than when using the LT fitting, with **a maximum difference of approximately 4.5m.**

3. Result and discussions

3.2 Carrying performance experiment

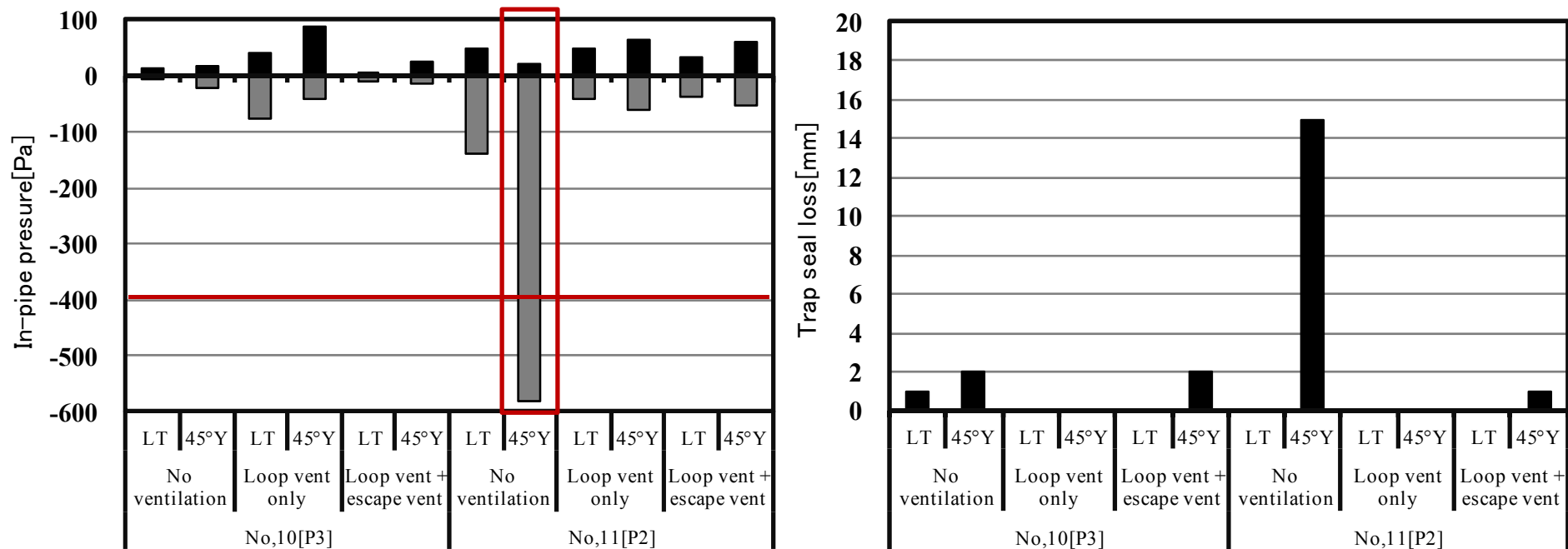


Fig. 7 In-pipe pressure at non-draining points Fig. 8 Trap seal loss at non-draining points

■ The in-pipe pressure exceeded the reference value of -400Pa only in pattern 11 using the 45° Y fitting and without ventilation, and there is no significant difference in the in-pipe pressure or the trap seal loss, with or without ventilation, when using the LT fitting.

■ Even in the case of using the loop vent pipe solely, adequate ventilation is still ensured and the in-pipe pressure remains unchanged, and this makes the effect of the escape vent pipe rather insignificant.