Experiment on flow capacity for drainage system of stack vent system with vent cap

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1 Introduction

In Japan, it's necessary to open an end of stack vent pipe in a drainage system to the atmosphere, and installs vent cap in an edge of the vent pipe is general. It's said that the design which considered vent resistance value and equivalent pipe length is important to a design of stack vent pipe.

This paper‘s purpose is that the flow capacity for drainage system of stack vent system with JIS-DT joint was grasped quantitatively.

And drainage flow capacity influence by vent resistance in a ventilation edge was considered using a typical vent cap based on the result vent resistance measured.

For this purpose, we conducted two experiments.

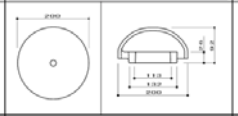
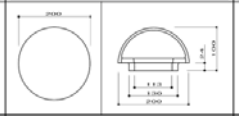
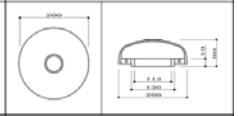
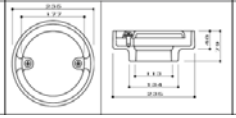
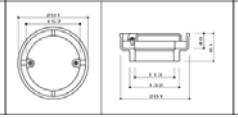
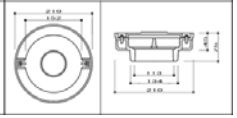
1. **Experiment in vent resistance of vent cap grasped**
2. **Experiment in the drainage flow capacity of the drainage stack system with a vent cap**

2 Experiment in vent resistance of a vent cap grasped

2.1 Experimental purposes

This experiment purpose is to grasp those vent resistance using **the exposed type** and **the embedded type of the vent cap** used for a drainage system of collective housing.

Table 1- The kind of vent caps

Company		Company D	Company K	Company I
Exposed type	type	A Ⅰ	A Ⅱ	A Ⅲ
	appearance			
	Detail view			
Embedded type	type	B Ⅰ	B Ⅱ	B Ⅲ
	appearance			
	Detail view			

2.2 Experimental methods

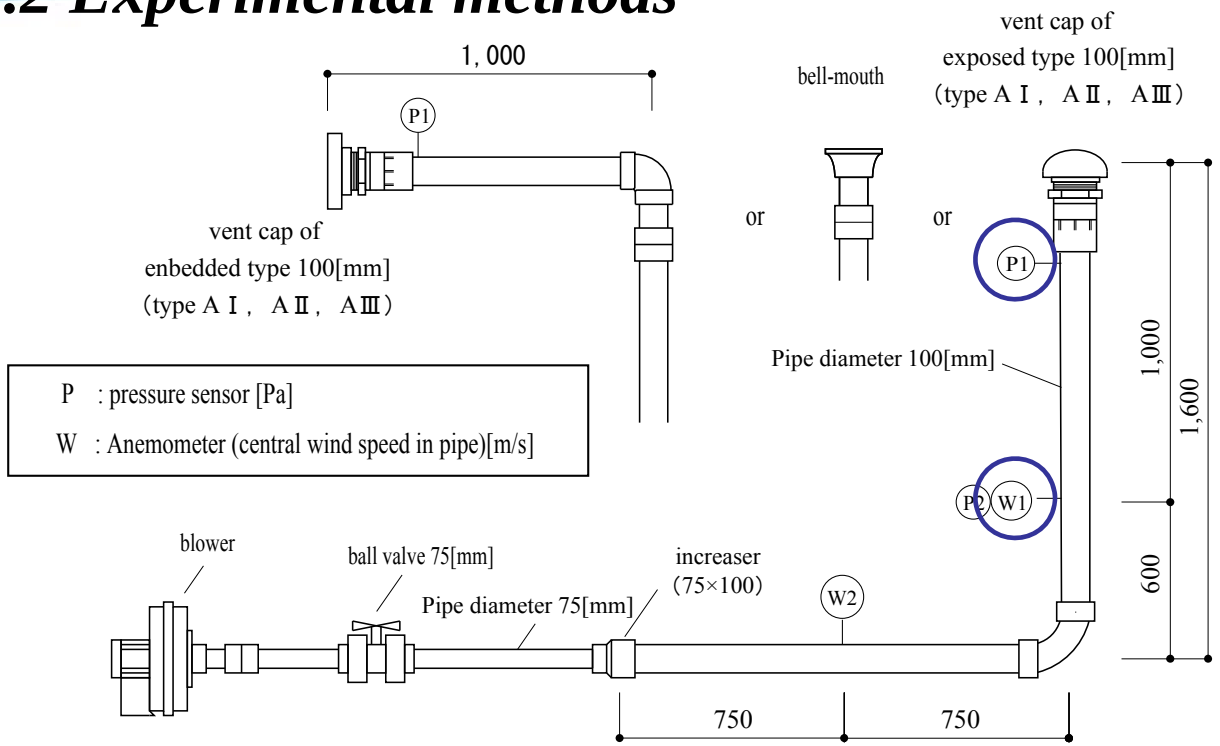


Figure 1- Vent resistance equipment

$$Re = \frac{Va}{\nu} \times D \quad \cdots \text{Equation (1)}$$

R_e : Reynolds number
V_a : Average wind speed in pipe [m/s]
D : Diameter of pipe [m]
ν : Viscosity coefficient of air [m^2/s]

$$P_1 = \zeta \times \frac{\rho}{2} \times Va^2 \quad \cdots \text{Equation (2)}$$

P_1 : Pressuer in pipe [Pa]
ζ : Vent resistance
ρ : Density of air [kg/m^3]
V_a : Average wind speed in pipe [m/s]

2.3 Experimental results of vent resistance and discussion

2.3.1 Vent resistance

- ✓ There was no great differences in the value of the vent resistance of each **exposed type**.
- ✓ The vent resistance of the **embedded type** was the result with the great difference in the value of BII more than BI and BIII.

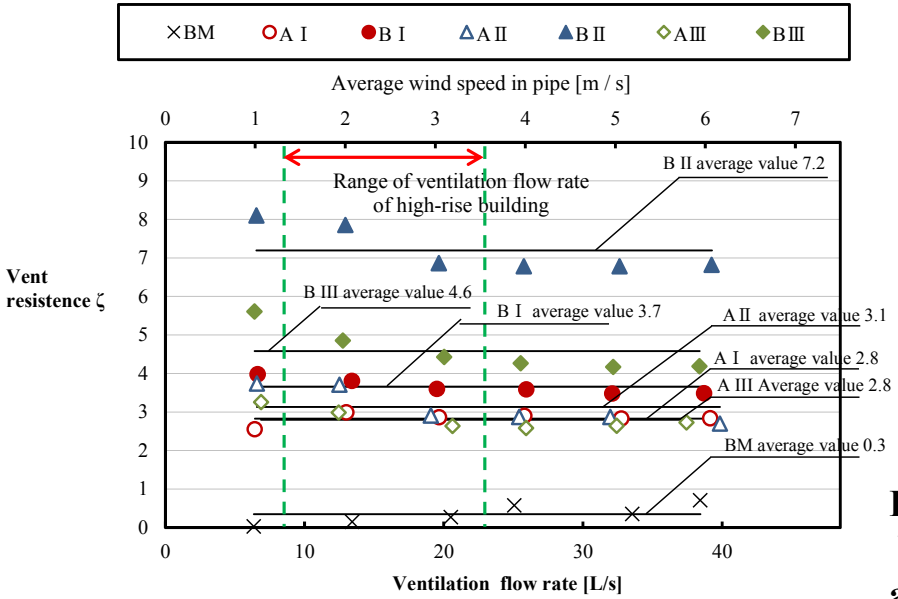
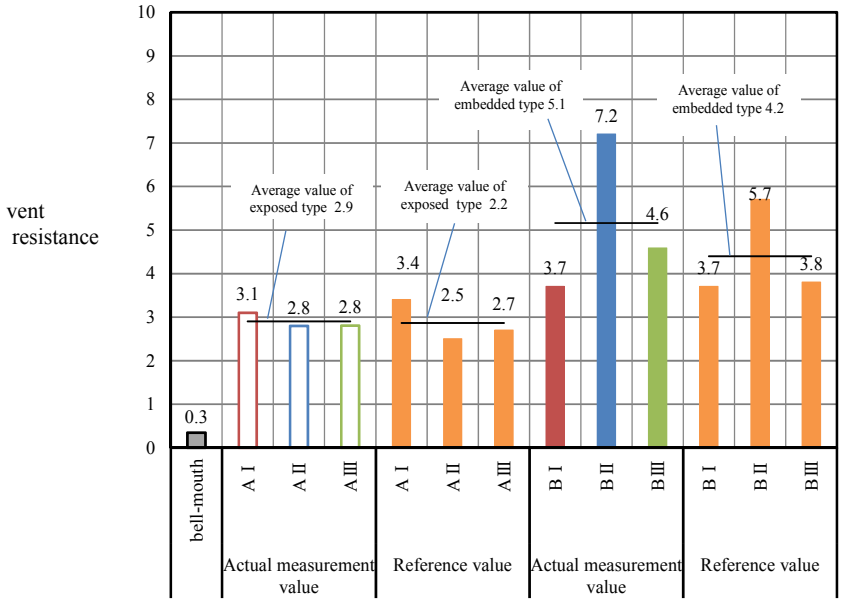


Figure 2-
Vent resistance of each vent cap-type and ventilation flow rate

2.3 Experimental results of vent resistance and discussion

2.3.1 Vent resistance

- ✓ When compared with the average value of the reference value, the measured value becomes larger than the reference value, the difference in value was 0.7 in the exposed type and 0.9 in the embedded type.
- ✓ When compared the average value of the exposed type of the measurement value and the average value of the embedded type, the embedded type has a larger vent resistance than the exposed type.



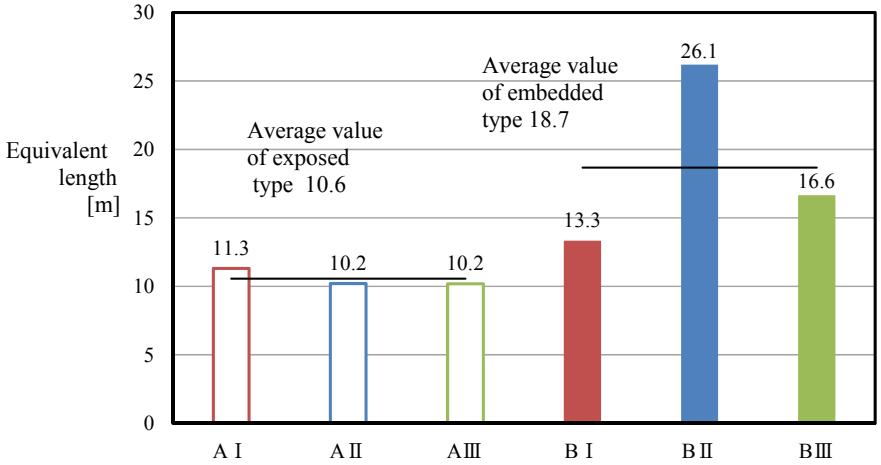
*The vent resistance of each vent cap in the past reference was shown in Figure 3 as a **reference value.**

Figure 3-
Average values of vent resistance in each vent cap type

2.3 Experimental results of vent resistance and discussion

2.3.2 Calculation of equivalent length

✓ When compared the average value of the exposed type and the average value of the embedded type, the average value of the embedded type was longer by 8.1 [m].



*** The equivalent pipe length** was calculated from the equation (4) using the vent resistance obtained by experiment by calculating the friction coefficient inside the pipe from the equation (3).

Figure 4-
Average value of equivalent pipe length in each vent cap

$$\lambda = 0.0055 \times \left\{1 + \left(2000 \times \frac{\varepsilon}{D} + \frac{10^6}{Re}\right)^{\frac{1}{3}}\right\} \quad \cdots \text{Equation (3)}$$

λ : friction coefficient inside the pipe
ε : Absolute roughness [mm]
D : Inner diameter of pipe [mm]
Re : Reynolds number [m/s]

$$L = \zeta \times \frac{D}{\lambda} \quad \cdots \text{Equation (4)}$$

L : Equivalent length [m]
ζ : Vent resistance
λ : friction coefficient inside the pipe
D : Inner diameter of pipe [m]

3 Experiment in flow capacity for stack vent system with a vent cap

3.1 Experimental purposes

The purpose of this study is to investigate the influence of the ventilation resistance at the end of the vent pipe on the flow capacity for drainage system.

At the end of the vent pipe of drainage stack system in the JIS-DT fittings, three types of exposed type vent cap, three types of embedded type vent caps and bell-mouths were installed, and grasp to the influence of the vent resistance of each vent cap on the flow capacity of the drainage stack system .

3.2 Experimental methods

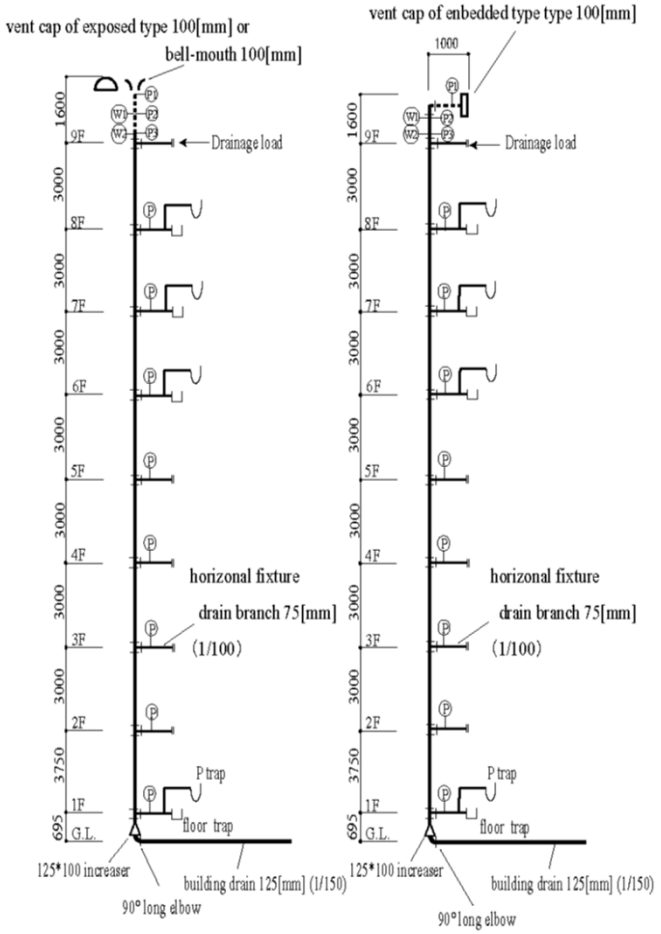


Figure 5-Drainage stack system

- Testing of flow capacity for drainage stack system was carried out using the test drainage stack system shown in Figure 5.
- 6 types of vent caps and bell mouths used in 2.2.1 were installed at the edge of vent pipe.
- The measurement items are 2 items, pipe pressure and center wind speed of pipe.
- The drainage load is based on SHASE-S218 and gives drainage load from 0.5[L/s] to 2.5 [L/s] in increments of 0.5 [L/s] from the 9th floor drainage branch pipe.
- The pressure in the pipe shall be within ± 400 [Pa] of pipe pressure in accordance with SHASE-S218.

3.3 Experimental results of vent resistance and discussion

3.3.1 Comparison of ventilation flow rate

- ✓ When the flow rate of the drainage load was 0.5 [L / s], the variation of the ventilation flow rate was observed for each type. However, as the drainage flow rate increases, the change in value decreases.
- ✓ When the flow rate of drainage load was 2.0 [L/s] and 2.5 [L/s], the difference in the ventilation flow rate was 1.2 [L/s], and the difference in the air flow rate was slight.

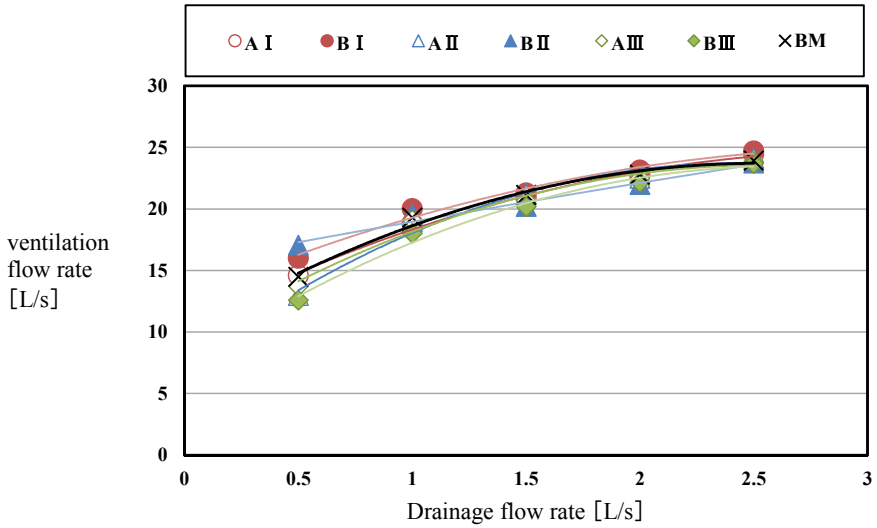
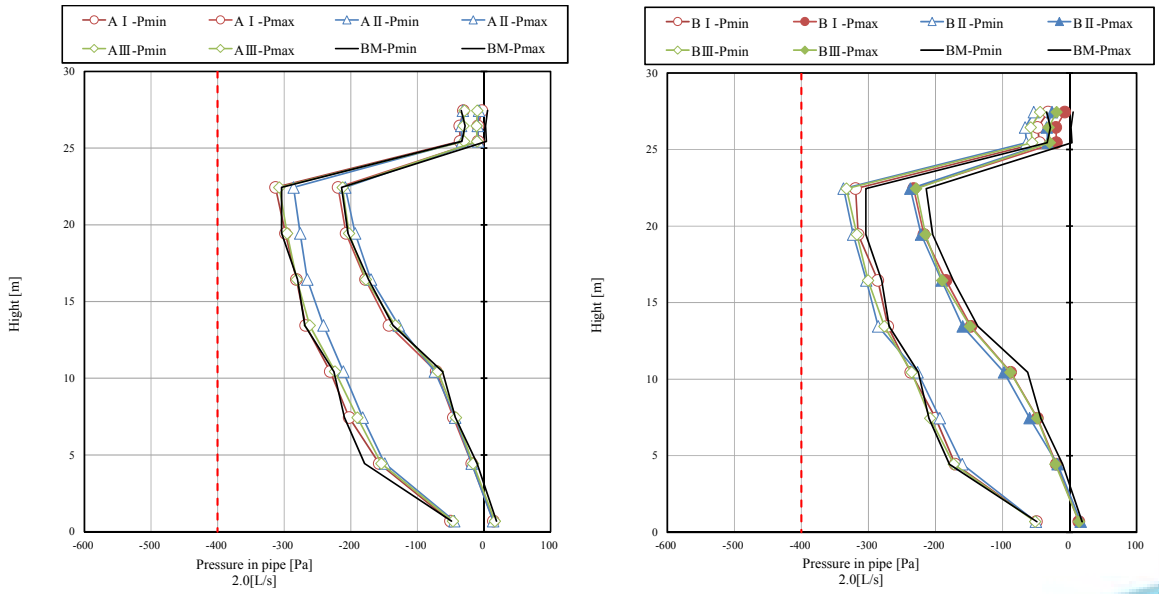


Figure 7- Comparison of the vent cap and the bell-mouth of ventilation flow rate

3.3 Experimental results of vent resistance and discussion

3.3.2 Comparison of pressure in pipe

✓ Even as the drainage load of 2.5 [L / s], there was no significant difference in the pressure in pipes at each floor depending on the type of vent cap, and the difference was about 50 [Pa] at the maximum.



(1)exposed of vent cap (2.0[L/s]) (2) embedded type of vent cap (2.0[L/s])

Figure 8- Pressure distribution in the pipe (as an example)

3.3 Experimental results of vent resistance and discussion

3.3.3 Flow capacity for drainage system

- ✓ The flow capacity for drainage system of the 6 kinds of vent caps was the same as 2.0 [L / s] as in the case of bell-mouth. [**Fig.9**]
- ✓ When the pressure in pipe was -400 [Pa],the difference in the value of the drainage flow capacity of each vent cap was 0.12 [L / s] at the maximum, and there was almost no difference. [**Fig.10**]

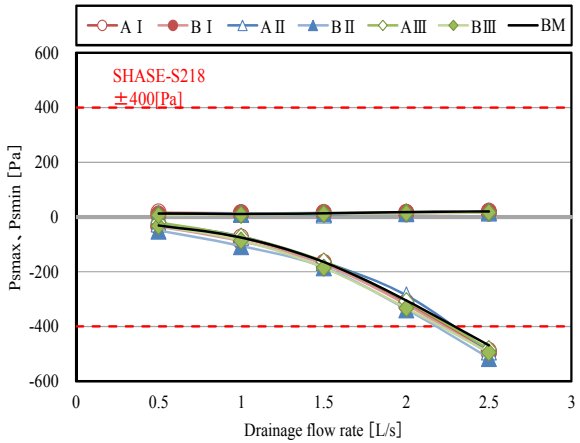


Figure 9- Comparison of flow capacity for drainage system

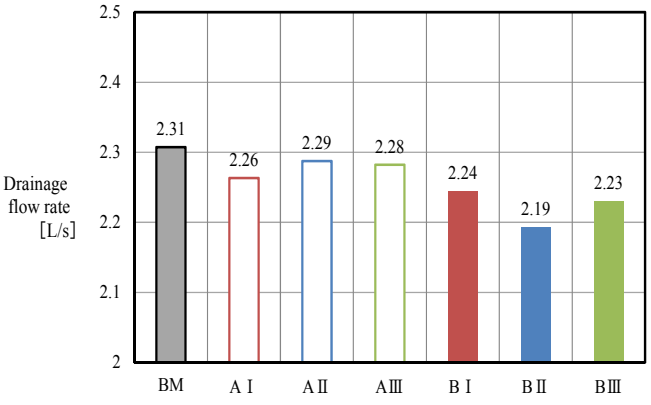


Figure 10- Comparison of the drainage flow capacity at -400 [Pa]

3.3 Experimental results of vent resistance and discussion

3.3.4 Calculation of vent resistance in experiment of flow capacity

- ✓ When comparing the vent resistance in the indoor and the vent resistance in the outdoors, when installing the vent cap outdoors, since it is affected by the outside air, the difference in vent resistance tends to become large.

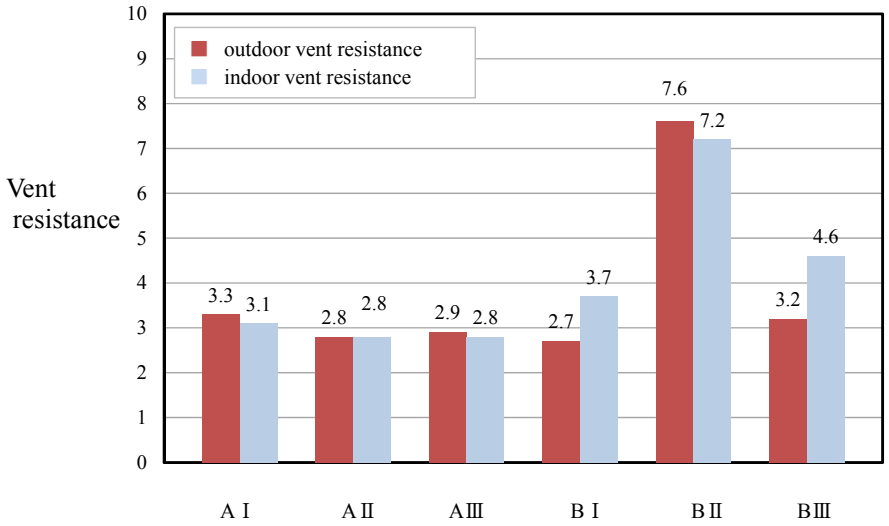


Figure 11- Comparison of the vent resistance

4. Conclusions

The findings obtained from the two experiments are shown below.

- In an experiment that grasped the vent resistance of each vent cap indoors, the exposed type vent resistances is smaller than the embedded type vent resistance, and have high ventilation performance.

- As a result of the experiment confirming the influence on the flow capacity of the drainage stack system, it was found that the distribution vale of pressure in pipe for each vent cap was maximum difference of about 50 [Pa], but the flow capacity for the drainage system in each vent cap was the same 2.0 [L/s] as bell-mouth.

4. Conclusions

- Comparing the outdoor vent resistance and the indoor vent resistance, there was a difference in the vent resistance between outdoor and indoor. It is inferred that there is a difference in vent resistance due to the influence of the airflow (outside wind) etc. around the vent cap and the likes.