# A study on the applicability of a hybrid drainage system to commercial building conversions

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■ The target floor was converted from an office(Fig. 2 (1)) to a gynaecology clinic(Fig. 2 (2)). 34 force-feed pumps of various types were installed. ⇒Added water supply spaces in this floor.





#### 2.Planning and overview of the hybrid drainage system.



Fig. 2 Concept of the hybrid system compatible with commercial building conversion



### 2.Planning and overview of the hybrid drainage system.

#### There are 4 kind of force-feed pumps in this system.

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 $\Rightarrow$ Target of measuring noise level and water pressure is 'force-feed pump(II)'. (Fig3,later)

legend	Force-feed Pump	Specifications		No.of Pumps inlled	legend	Force-feed Pump	Specifications		No.of Pumps inlled
-	(I)	Туре	Sewage/Watewater Drainage System	- 1	—	(II)	Туре	Sewage/Watewater Drainage System	4
		Pump Capacity	175L/min				Pump Capacity	50L/min	
		Tank Capacity	200L				Tank Capacity	20L	
		Head	12m(120kPa)				Head	12m(120kPa)	
-	(III)	Туре	Watewater-only tank-less force-feed Drainage System	25	_	( <b>V</b> I)	Туре	Sewage/Watewater tank-less Drainage System	4
		Pump Capacity	35L/min				Pump Capacity	35L/min	
		Head	6m(60kPa)				Head	6m(60kPa)	





Photo. 1 Force-feed drainage pumps

Fig. 3 Force-feed drainage pumps and the pump capacity curves thereof





Fig. 4 System diagram of the conversion-compatible drainage system

- Waste water flows from the 15th floor to the 8th floor (through house drain and drainage stack). ⇒Measuring water level (at point H of the house drain, **Photo2**, **Convert to load flow rate**),
- 6 and the in-pipe pressure (at point P, of the drainage stack, Photo3).

## 3. The scope of the investigations to be conducted



Fig. 5 Noise level measuring points - plane view

Photo 4 Noise level measuring point (Point ①, In the pump booth)

(2)'investigation of the influence of force-feed drainage pump noise'
Simultaneously measuring the noise level at point ①(Photo 4) and at points ② to ⑧ (point ⑧ is outside the pump booth), respectively, with another noise meter.



#### 3. The scope of the investigations to be conducted



Photo5 Water pressure measuring point

Fig. 6 The outline of the pump for measurements

**Noise level** 





#### 4. Consideration of influences on the existing drainage stack system



Fig. 7 Transition of the maximum drainage load flow rate during the measuring period (2015/9/24-2016/2/21)

#### The maximum value is approximately 2.5[L/s],

This value is approximately 44% of 5.6[L/s], the allowable flow rate for 100A (pipe gradient 1/100) horizontal drainpipes in accordance with SHASE-S206.

⇒No need to increase diameter of drainage stacks and offsets.



#### 4. Consideration of influences on the existing drainage stack system



Fig. 8 The number of times of generating drainage loads on a weekday and Saturday (Extracted excerpts from several days.)

Most of the load flow rates are less than 1.0[L/s].
1)Weekday= approximately 80% of the drainage load flow rates are roughly 0.5[L/s].
2)Saturday= approximately 90% of the load flow rates are about 0.5[L/s] even at the highest.

Only 1% of the drainage loads were generated at 1.5-2.5[L/s] during each day.



#### 4. Consideration of influences on the existing drainage stack system



Fig.9 Variations of maximum and minimum pressure values during the measuring period (24 Sep. 2015 to 25 Dec. 2016)

 The maximum value (negative pressure) ...approximately -300Pa. (positive pressure) ...approximately 180Pa.

=The variation of the in-pipe pressure is approximately 75% or less of the SHASE-S218-specified threshold of  $\pm 400$ Pa. safely without any concerns.



#### 5. Consideration of the influence of noise generated by the force-feed drainage pump



Fig. 10 The noise level measured at point <sup>①</sup> during pump operation and the water pressure in the force-feed drainage pipe

The pump noise into four groups depending on the operation stage.

- (1) The noise generated at startup.
- (2) The noise generated during motor operation.
- (3) The impact noise generated at shutdown.
- (4) The background noise after shutdown.



5. Consideration of the influence of noise generated by the force-feed drainage pump

 Point (a) (in the entrance) during motor operation =between 39[dB(A)] and 45[dB(A)].

 Point 2 (in the toilet booth) The maximum noise level
 = approximately 52[dB(A)] (Impact noise at shutdown)

The impact noise generated at shutdown can have a little influence on the rooms surrounding the pump booth.



(2) Noise levels at point ① and point ②Fig. 11 Noise levels measured at point ① and points ② and ⑧ during pump operation

#### 5. Consideration of the influence of noise generated by the force-feed drainage pump



Fig. 12 Comparison of the averages of noise levels measured at the measuring points and at the pump operation stages

# In the entrance, (at point (8)

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The noise of the pump in operation was measured approximately 50[dB(A)]. (=It's lower than 60[dB(A)] by general conversation.)

## In the toilet booth, (at 2 to 8 point )

The maximum level of impact noise at shutdown is approximately 53[dB(A)] (=It's lower than the maximum noise level of 80[dB(A)] measured when flushing a gravity-type toilet.)



The effectiveness of our proposed hybrid system was verified from the experiment. Our findings are as follows:

- (1) The variation of drainage load is in a range that is approximately 44% of the allowable range for 100A house drains in accordance with SHASE-S206, and there is no need to increase diameter of drainage stacks and offsets.
- (2) The variation of the pressure in the drainage stack is in a range that is approximately 75% of the reference range specified by SHASE-S218(±400[Pa]).
- (3) The noise level generated by the force-feed drainage pump was lower than that of a general conversation(60[dB(A)]) and that of flushing a gravity-type toilet(80[dB(A)]).

# =Therefore, effectiveness of adapting this proposed hybrid drainage system to building conversions has been verified.

