Utilization of In-pipeline Water Level Information for Inland Flood Control Measures

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1. Introduction

In recent years, the risk of inland flood damage caused by rainwater overflowing on the ground from the sewerage system in excess of its capacity has been increasing in accordance with the increase in local heavy rain. Since development of inundation control facilities, including storage facility, takes a lot of cost and time, inundation control methods using the capacity of existing stock to the utmost is required for early damage mitigation.

In general rainwater pump stations, operation is based on the water level of the pump well. Since it takes a certain time to start up the pump, it may be difficult to respond to a sudden increase in inflow resulting from uneven distribution of rainfall or sudden heavy rain. We therefore studied on selection of water level measuring points and utilization of water level information in order to raise the efficiency of rainwater pump operation in the event of heavy rain by using the in-pipeline water gauge, which is relatively easy to maintain.

2. Study method

Using a pumping drainage area, 329 ha in area and about 3.8 km in trunk pipeline length, as a model drainage area, we examined proper water level observation points and pump operation control method through analysis of variation of in-pipeline water levels at the time of rainfall and analysis of inundation situation (flood analysis). In examination, movement of rainfall was indicated by using the centralized rainfall pattern as shown in Fig. 1, which exceeds the facility's capacity, and changing rainfall start time and order of start with the drainage area separated into three areas (upstream, midstream, downstream).

3. Study results

It was confirmed from the results of analyses that timing of water level rise varies according to

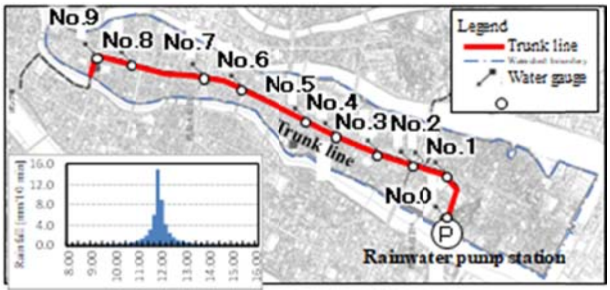

Fig. 1: Model drainage area plan view and rainfall studied

observation points and moving patterns of rainfall and that there is a case where increase in inflow by heavy rain can be detected earlier than measurement at the pump well by using observation values at the points where water level rise is earlier than a pump well (Table 1). It was also found from results of the flood analysis that inundation area will be reduced by making the pump start-up timing earlier in the event of heavy rain using the detection information at the water level observation points shown in Table 2, which is particularly effective for rain that first falls in the upstream area.

Note that in some rains, the pump started before increase in inflow and the control system caused problems in operation, including pump stop due to sudden water level decline and sequential occurrence of start-stop. Accordingly, it is also necessary to take measures considering inflow, not only to simply accelerate the timing of start-up.

4. Conclusion

We have confirmed the possibility of reducing inundation area with utilization of in-pipeline water level information. We are now studying reflection of operation control conditions according to pump facility types and proper operation method. In the future, we are going to collect findings from these studies and organize the procedures for introducing operation with utilization of in-pipeline water level information into pump stations.

Table 1: Difference between the time to reach five-divided water in the pipeline and pump starting time (minutes)

Rainfall moving patterns	No.1	No.2	**No.3**	No.4	No.5	No.6
Uniform rainfall	-5	8	**20**	15	10	6
Downstream → midstream → upstream 15-min. interval	-9	-2	**7**	1	-5	-13
Downstream → midstream → upstream 30-min. interval	-11	-9	**-6**	-13	-20	-29
Upstream → midstream → downstream 15-minute interval	2	16	**29**	25	22	22
Upstream → midstream → downstream 30-minute interval	8	22	**35**	33	31	34
Center → upstream-downstream both ends style both ends 15-min. interval	0	13	**25**	20	14	6
Center → upstream-downstream both ends style both ends 30-min. interval	4	16	**28**	23	17	6

* Note: Depth of color represents extent of time allowance (blue) or extent of delay (red)

Table 2: Water level observation points and reduction of inundation area (ha) by control operation

		Present operation	No.1 point	No.3 point	No.5 point
Uniform rainfall	Inundation area	62.01	62.00	61.79	61.80
	Reduction area	-	0.01	0.22 (maximum effect)	0.21
Downstream → Midstream → Upstream 15-min. interval	Inundation area	60.04	60.01	59.95	60.04
	Reduction area	-	0.03	0.09 (maximum effect)	0
Upstream → Midstream → Downstream 15-min. interval	Inundation area	59.63	59.63	59.01	59.02
	Reduction area	-	0	0.62 (maximum effect)	0.61