IN-SITU EXPERIMENT OF SNOW-MELTING PIPE SYSTEM CONTROLLED BY INVERTER AT NAGAOKA, JAPAN

YUSUKE FUKUSHIMA[1]

[1]Professor, Department of Civil and Environmental Engineering, Nagaoka University of Technology, 1603-1, Kamitomioka, Nagaoka, Niigata 940-2188, Japan
(Tel: +81-258-47-9614, Fax: +81-258-47-9600, e-mail fukusima@nagaokaut.ac.jp)

The new system of snow-melting pipe is developed for the Japan Sea side where the winter weather is relatively mild. The mechanism of the snow-melting pipe is as follows. The warmer underground water with a temperature of 12-13^oC is sprinkled over roads covered by snow to melt it. The conventional snow pipe was controlled by the snow sensor which is switched on or off the pump to pump up the underground water. The new system uses the snow intensity sensor and the inverter which controls the mass of the pumped-up water. Thus, the new system controls the pump efficiently and which is saving the underground water set on electrical energy. This study was conducted to verify the efficiency of the new control system at the road of Nagaoka City. In-situ experiments of this study were carried out by the cooperation among the university, the city office and private companies.

The experimental setup was as follows; the snow intensity meter, the ultrasonic discharge meter, the inverter-controlled pump, the three live cameras and two snow pipe systems with nozzles to sprinkle water. One of the two systems was a conventionally controlled snow pipe to compare it with the other new system. All data were sent through the internet using ADSL. How much snow over the road has melted was checked by digital live cameras. One of the objectives of this study was to test the feasibility of the new system of snow-melting pipe using the actual road.

The sites were the city roads located at the Nakajima 4-chome and the Nakajima 6-chome in Nagaoka City. The new snow-melting pipe system which was set at the 4-chome, was compared with the conventional system at the 6-chome.

The following items were measured at the 4-chome. (1) snow intensity meter, (2) flow rate (measuring discharge of the pump up), (3) pressure sensor, (4) level of the underground water, (5) state of snow over the road by live cameras

All data were collected through the internet using ADSL. This made it 24 hours observation possible and data collection in in-situ experiment. This led us to gather satisfying data for all experimental period. The experiments were carried out for two snowy seasons: 2002-2003 and 2003-2004 winters. The measurement period was January 15 to March 31 in 2003 and December 15 in 2003 to March 15 in 2004. In these periods, all data were collected with no trouble. This is due to the internet. Thus present experimental results are valuable examples of the new snow-melting pipe system.

The capacity of pumps at Nakajima 4-chome and Nakajima 6-chome was the same. But the pipe lengths were a little different. The figures at the 2003 winter are shown in Fukushima et al. (2003).

This snow intensity meter controlled the pump-up discharge of the underground water in real time. The pressure sensor was set just downstream of the pump. The correlation between the pressure sensor and water discharge was checked and hydraulically analyzed in this study. Thus the pressure meter can be used to control discharge instead of the expensive discharge meter. The snow depths were measured to read the pictures of the scale set at the Nakajima Central Park (6-chome) shown by the live camera. These data are compared with the AMeDAS data at Nagaoka City.

The data of the total pumped up discharge, working time of the pump and using electricity of two winter seasons at Nakajima 4-chome (new snow-melting pipe system) and Nakajima 6-chome (conventional snow-melting pipe system) were summarized in the period of the first winter is January 15 to March 15, 2003, and in the period of the second winter is December 15, 2003 to January 27, 2004. Those values per unit length were also calculated because the lengths of two snow pipes were a little different. From these data, volumes of water used for the new system is 40%, the working time is 50% and using electricity is 30% to 40% compared with the conventional system. Thus, the new system of snow pipe can save the amount of water and the electrical energy.

Using the value of the energy loss coefficient, the discharge was estimated by the pressure sensor, compared with the discharge measured by the ultrasonic flow meter shown in Figure 1 (January 29, 2003; On this day, the maximum daily discharge was observed). When the snowfall intensity was large, the observed discharge and the estimated discharge agree well.

Thus, the discharge can be measured by the pressure sensor, the use of the expensive ultrasonic flow meter is not necessary. The price of the total system for the new snow-melting pipe, which includes the snowfall intensity meter, the inverter which controls the pump-up discharge, will become cheaper and popular for the inhabitants in snowy area.

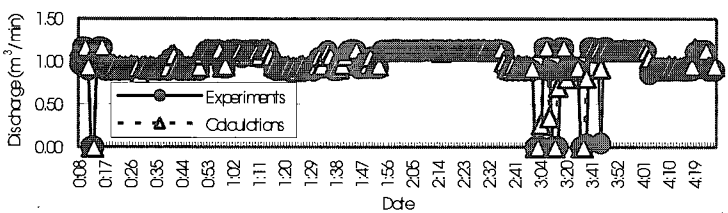

Fig. 1 Comparison between the discharge estimated by the pressure sensor and the discharge observed by the experiment.(January 29, 2003)

REFERENCES

Fukushima, Y., Kimoto, J., Hara, M., Kobayashi, T., Sakai, R., Ishimaru, T. and Hachinohe, T. (2003) "Performance test of snow pipe system controlled by inverter in field (No. 1)," *Seppyo (Journal of Japanese Society of Snow and Ice)*, Vol. 65, No.4, pp.399-403.

Fukushima, Y., Kimoto, J., Hara, M., Kobayashi, T., Sakai, R., Ishimaru, T., Hachinohe, T. and Ishikawa, Y. (2004). "In-Situ experiment of snow pipe system saving underground water (No. 2)," *Seppyo (Journal of Japanese Society of Snow and Ice)*, Vol. 66, No.4, 495-502.

Hino, M.(1983) *Hydraulics*, Maruzen, p. 174.