Research on the steep gradient sewer utilities

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(Purpose)

This study extracts hydraulic examining subjects based on established cases and past research results of steep gradient sewer, and carries out the hydraulic model study for the important subjects (design method of tubular section, design method of alignment and design method for energy dissipation utilities), and it is coordinated as a basic data for the design standardization.

Established cases of steep gradient sewer show in the following 7 cases.

- Steep gradient sewer in the Nagano City. (the commencement of service in 1995)
- Steep gradient sewer in the Otsu City. (the commencement of service in April, 2000)
- Haneo line steep gradient sewer (Naganohastorm-Gunma Prefecture)
- Zao process zone trunk line (Yamagata City, Yamagata Prefecture) (under construction)
- Steep gradient sewer in the Atami City. (under construction)
- Steep gradient sewer in the Suzaka City. (under construction)
- Mt. Aonoyama steep gradient sewer. (Yoshino town in Nara Prefecture)

(1) Arrangement of the established cases and extraction of the hydraulic subjects.
   - Grasp of air entrainment and contamination phenomenon and design method of tubular section of sewer
   - Design method of alignment.
   - Design method of variants of energy dissipater

(2) Hydraulic model study for the important subjects

(3) Examination of standardization and subject arrangement after the next fiscal year.

Above subjects are arranged, and the necessary hydraulic subjects for examination of the design standardization are extracted and arranged.

(Result)

(1) air taken /entrained phenomenon.
   - Aeration quantity
   
   The aeration quantity is obtained by the area which subtracted the area of flow entrained air from the area of uniform flow without entrained air.

   The extension of the application became possible.
   - Range of Fr: 8<Fr<16.
   - Range of the flow velocity: 4.6m/s<V_{w}<12.7m/s.
   - Range of the water depth: 0.11<R_{w}/D<0.36.

   - Entrained air quantity
   
   It is possible to calculate the taken air quantity by subtracting obtained entrainment air quantity from supplied air quantity of experiment. Still, that the relation between air entrainment speed V_{ap} and flow velocity V_{w} is as same to past result was able to confirm by experiment.

(2) Energy dissipation function.

In the experiment, the following were verified for draft shape of energy dissipater: dissipation situation due to the hydraulic jump in the case which changed discharge and discharge characteristic of the sill with...
By applying the past research result on energy dissipater, it was proven that the design on the energy dissipation function was possible.

(Future problem)
(1) On the design method of section of steep gradient sewer, it is almost possible to clarify for straight part, and for the curve part, the research by the experiment is necessity in future.
(2) On the design of the energy dissipater, it is necessary to examine the design technique of the utilities which combine energy dissipation function and water flowing function of sewage.

The peculiar research: Japan institute of Wastewater Engineering Technology
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Key Words
Steep gradient sewer, air entrainment phenomenon, aeration phenomenon, pulsation event, energy dissipater, uniform flow condition, linear interval, curve interval, gradient variation interval, phenomenon of hydraulic jump, slit bill sill, Froude number. J902B1010.