Research on a Helicodal-Ramp Type Drop Shaft

Year of Research	2007・2008	

(Purpose)

A helicodal-ramp type drop shaft installed at high head drop connection manholes on sewage systems (below referred to as "DRS") is high head drop work which efficiently absorbs energy to allow water to fall gently to the bottom by artificially creating and sustaining a spiral flow in its helicodal-ramp. The use of DRS has been growing in recent years. In 2002, the Institute published the Revised Design Documents on Helicodal-Ramp Type Drop Shafts (Draft) (below called "Design Documents (Draft)". However, since then, a variety of new challenges have appeared as the depths and flow rates have increased, methods of causing water to flow into DRS diversified, and air entraining countermeasures have been taken. This research is intended to study these challenges, verify them by hydraulic model testing, and prepare a technical manual which reflects the results.

(Results)

(1) Flow rate measures

The range of application in the Design Documents (Draft) was originally diameter of 2,800mm (design flow rate of approx. 10m^3/s), but as later large diameter executions were performed, and FRPM tube with diameter of 3,000mm came into use as pipe material, the range has now been expanded to 3,000mm (design flow rate of 13m^3/s).

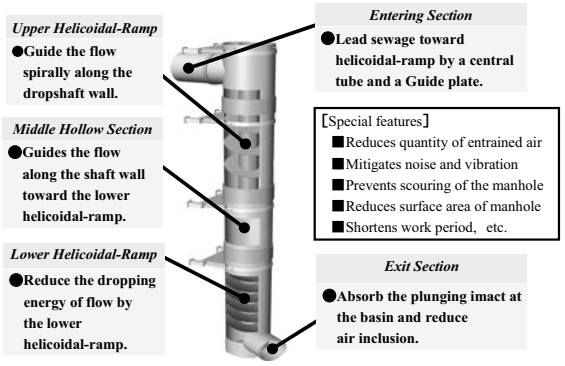

Figure 1. Basic Structure and Features of DRS

(2) Drop head measures

The Middle Helicodal-Ramp Drop Shaft (addition of the Helicodal-Ramp to the intermediate guideway section, so it now includes top, middle, and bottom helicodal-ramp) developed in anticipation of deeper installations in the future, was newly inserted. This permits handling of head drops up to 28 times the DRS diameter. But none have been constructed in a range exceeding a head drop of 45m, and studies to verify of the strength of members and of air entraining are inadequate, so the application range remains at the original 45m.

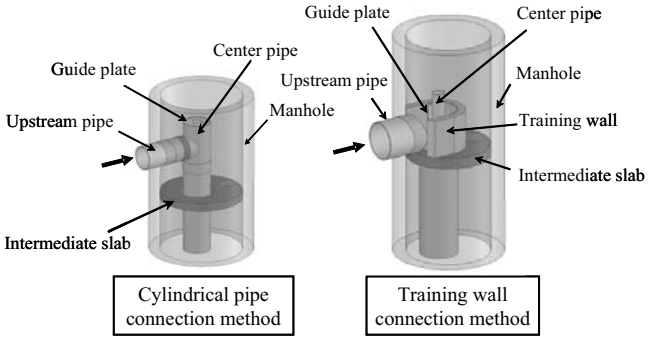

Figure 2. Method of Connecting DRS to the Upstream Pipe

(3) Diversification of inflow methods (hydraulic model testing of tank connection methods)

The top inflow part of a DRS is basically a cylindrical pipe connection, but another water tank connection method—installing a tank-shaped wash bulkhead so that water flows in from all directions—is coming into wider use. The functions of this method were verified by testing, resulting in concern that with this method, long-cycle water surface fluctuations would occur inside the tank, resulting in backwater impacts on the upstream pipe, damaging facilities and producing vibration and noise. As an inflow shape to replace this approach, a new training wall connection method has been proposed. The manual includes an explanation, design method, etc. concerning the training wall connection method, as a replacement method for use in a case where the distance from the manhole wall is short, the center of the DRS is eccentric in relation to the central shaft of the inflow pipe, and other cases where the cylindrical pipe connection method cannot be used.

(4) Air-entraining countermeasures (hydraulic model testing of an air exhaust system consisting of air intake pipes)

An air exhaust system consisting of air intake pipes, which are air intake pipes with porosity (diameter of approx. 5mm) installed at the tops of trunk connecting pipes, captures entrained air and discharges it outside the system. The testing verified its functions and obtained new knowledge concerning the required length of the air intake pipes according to the dissolved air flotation distance, and the effectiveness of drainage pipes installed at bends in the air intake pipes. The results of the testing are presented in the data document as reference material.

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