AN EXPERIMENTAL STUDY OF FLOW IN A VORTEX DROP STRUCTURE

G. CHRISTODOULOU and T. PAPATHANASSIADIS

Applied Hydraulics Laboratory, Dept. Civil Engineering
National Technical University of Athens
5 Heroon Polytechniou, Athens 15780, Greece
(Tel: +30-2107722813; Fax: +30-2107722814, e-mail: christod@hydro.ntua.gr)

In drainage networks there are occasionally large elevation differences between near surface conduits and main collectors. In such cases simple drop manholes are not suitable and vortex drops need to be employed, where significant energy dissipation occurs due to friction of the rotating flow on the dropshaft wall.

A vortex drop structure in the Athens area was studied on a physical model at a scale of 1:10, as described in detail by Christodoulou (2002). The design discharge was 15 m^3/s and the elevation difference between the inlet and the bottom outlet was about 35 m. The incoming flow was supercritical, with Froude numbers between 3.17 and 3.36. The structure, consisting of the spiral intake, the vertical dropshaft and the bottom outlet chamber, was preliminary designed according to Hager (1999). In particular the shaft diameter was chosen as D_s=2.40 m, the largest radius of the spiral was R_1=3.25 m and the dimensions of the bottom chamber were 25 m (length) x 13 m (height) x 7 m (width), based on the size of the outlet conduit to the main collector tunnel.

The experimental setup is shown in Fig. 1. The desired flow depth at the inlet and the tailwater level in the bottom chamber were controlled by sluice gates. Five runs were carried out with flowrates between 5 and 15 m^3/sec. Experimental measurements included mainly the water levels along the outer wall of the spiral and in the bottom chamber.

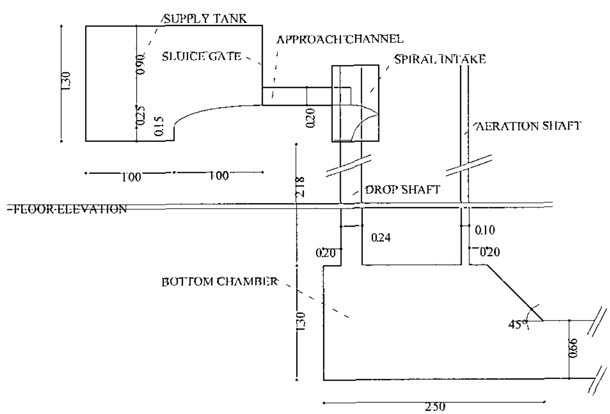

Fig. 1 Experimental setup (dimensions in m)

A good agreement was observed between the measured water levels on the outer wall of the spiral and the formula suggested by Hager (1990), as shown in Fig. 2. Concerning the flow down the shaft, visual observation and pressure measurements showed that the flow was well attached to the wall, except partly for the smallest flowrate tested (5.0 m^3/sec). The computed efficiency of the dropshaft is shown in Fig. 3, indicating an appreciable energy dissipation; the efficiency decreases with increasing flowrate since the length of the shaft is insufficient to achieve equilibrium conditions at high flowrates. Finally, it was found that the bottom chamber was oversized and could be made appreciably smaller.

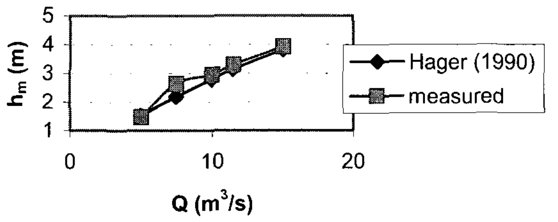

Fig. 2 Maximum water level on the spiral outer wall

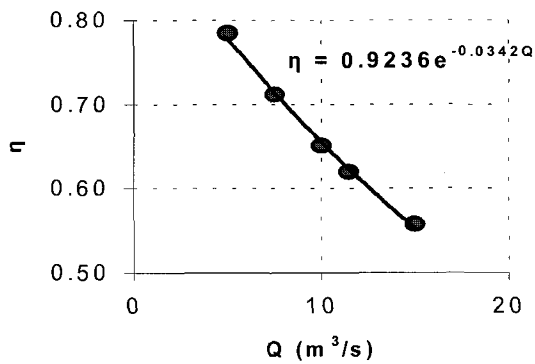

Fig. 3 Efficiency of the shaft

Keywords: Vortex Drop; Physical Model; Spiral Flow; Energy Dissipators; Stormwater Drainage; Drop Manholes.

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