Laboratory Experiments on the Three-dimensional Flow in a Junction Manhole

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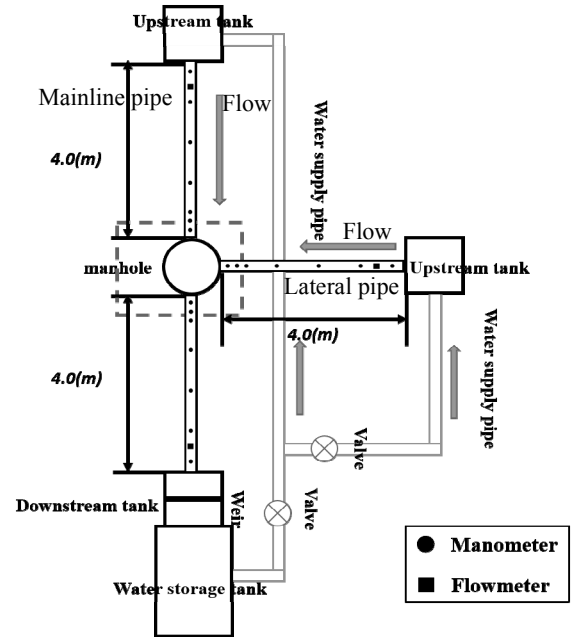
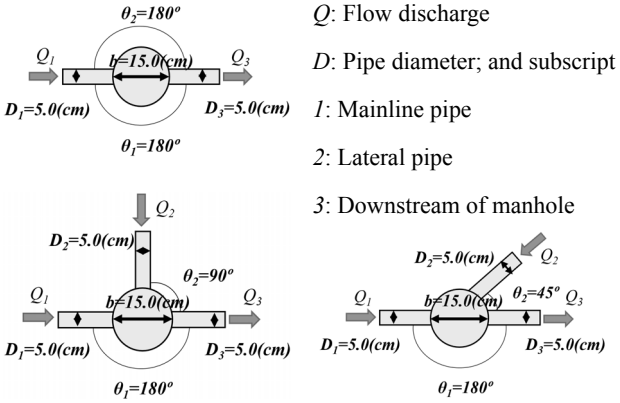
Junction manholes are one of the most important structures in an urban storm drainage system. They provide easy access to sewer pipes for underground inspection and cleanout, as well as allow joining of sewer pipes with different alignments, sizes, slopes, elevations and geometries. Junction manholes largely facilitate the design and the maintenance of the storm drainage system. On the other hand, they sometimes become bottlenecks of the system as they may exert negative impacts on the drainage efficiency. In the past several decades, the energy losses due to junction manholes have attracted a lot of attention for the quantification of those negative impacts, and various empirical and semi-empirical formulae have been proposed. Unfortunately, as the local flow details are not well understood, the mechanisms of the energy losses are not clarified. In this research, the detailed flow structure in a junction manhole is investigated to further the understanding on the local energy loss.

A series of laboratory experiments were conducted in the Ujigawa Open Laboratory, Kyoto University. The experiment setup is shown in Fig.1. The sewer system consists of a mainline pipe and a lateral pipe, connected by a circular junction manhole. Different scenarios have been investigated by changing the joining angle and the discharge ratio between the mainline pipe and the lateral pipe. The local flow structures in several representative horizontal and vertical planes in the manhole are analyzed with a PIV method. The experiments demonstrate that the local flow in the manhole is strongly three-dimensional. Typical local flow structures are characterized and their implications on energy losses are discussed.



(a) Mainline/lateral sewer pipe system



Q: Flow discharge

D: Pipe diameter; and subscript

1: Mainline pipe

2: Lateral pipe

3: Downstream of manhole

(b) Details of the junction manholes with different joining angles (180°, 90°, 45°)

Fig.1 Sketch of the sewer pipes and junction manholes

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