

Supercritical flow in bend manholes

- Prof. Dr. Willi H. Hager
- Prof. Dr. Corrado Gisonni, Università di Napoli

Bend manholes in combined sewers with a supercritical approach flow are characterized by the development of shock waves, due to flow deflection. Based on previous research it was found that the discharge capacity of the 45° bend manhole is smaller than for 90° deflection. The reason for this flow anomaly may be explained with the location of the wave maximum always close to 45 degrees and thus close to the intake of the 45° downstream sewer.

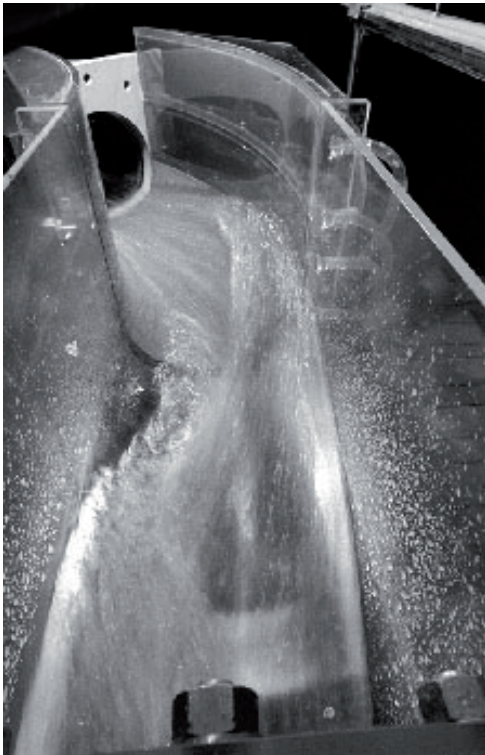


Fig. 1: Tailwater view of supercritical flow in a 45° bend manhole with bend extension.

An improved design was thus developed, consisting of the bend manhole extended by a straight U-shaped manhole piece of 2 diameter length. This bend extension results in a discharge capacity almost identical with the 90° bend manhole without extension, and in improved downstream flow conditions. Fig. 1 shows the improved manhole design.

Under-designed bend manholes can be subjected with dangerous phenomena, including the development of two-phase surging flow or even water hammer so strong that the manhole cover is lifted in the air and endangers persons and vehicles on roads. Provided the actual discharge is larger than the capacity discharge, additional measures have to be taken:

- Either a bend extension is added to an existing and traditionally designed structure, or
- a manhole cover is inserted to inhibit wave development higher than the manhole benches.

The latter design with a partially pressurized flow increases the discharge capacity significantly but is not a standard in sewers, given that it should always run under free surface conditions. Accordingly, with the manhole cover, an intensive maintenance is needed to check whether deposits clog the manhole. The optimum elevation of the cover is 90% of the sewer diameter above its invert to allow for aeration of the downstream sewer. Also, the manhole cover should be easily removable for inspection and maintenance.

Keywords:	Bend, Sewer, Manhole, Supercritical Flow
Commissioned by:	Abwassertechnische Vereinigung ATV, Germany

