Repairing a blocked culvert pipe - a combination of two cleaning methods led to success

By Ralf Saftig and Norbert Klein

Difficult situations require extraordinary measures. This was also the case in Koblenz when the DN 500 wastewater pipe in the culvert tunnel was blocked and only the parallel DN 1000 pipe was available for wastewater disposal. Upgrading was extremely urgent because the transportation of wastewater would no longer be guaranteed in the event of storms, which were becoming increasingly frequent. It was not possible to dismantle the pipes in the tunnel to remove the blockage. New ideas were necessary. The combination of high-pressure flushing vehicle, Comprex process and PE pipe with improvised flushing nozzle finally led to success. Boards, plastic conglomerates, stones, sand and other impurities were removed. The measure showed how clogged culvert pipes can be upgraded quite easily. In a further step, new maintenance concepts are planned for wastewater culverts that are not designed for cleaning and inspection.

The Rhine culvert tunnel

The Rhine culvert tunnel between Koblenz and Ehrenbreitstein was planned in the 1970s to connect the areas on the right bank of the Rhine with Koblenz on the left bank (***Fig. 1***). The tunnel was mined between 1979 and 1982 in the slate under the Rhine [1]. It is 370 m long, runs 16 m below the bed of the Rhine (Fig. ***2***) and has various functions. For example, the tunnel structure contains three DN 400 drinking water pipes and three DN 200, DN 500 and DN 1000 wastewater pipes (***Fig. 3***), all made of ductile cast iron [2]. The wastewater pipes transport the wastewater from the districts on the right bank of the Rhine to the Wallersheim sewage treatment plant. The sewage pipes and sewage treatment plant are operated by Stadtentwässerung Koblenz (SEK).

The wastewater from the areas on the right bank of the Rhine flows into the inlet structure (***Fig. 4***). In the approximately 30 m deep inlet structure, the wastewater pipes first run vertically between two 90° bends to the low point, before rising only slightly in the tunnel and then rising by up to 60 % on the last 50 m on the Koblenz side (***Fig. 2***). The lower 90° bends are encased in concrete to dissipate longitudinal forces.

Figure 4 illustrates the problem of maintenance. The removal of pipes or fittings in the tunnel structure is only possible with a great deal of technical effort. In addition, the culvert pipe would be out of operation for a longer period of time. The 90° bends at the inlet structure prevent access to the cleaning tools, so that cleaning work can only be carried out from the culvert outlet (lower head), i.e. only from the Koblenz side.

are feasible. At the culvert underhead, however, the tight space conditions make working difficult. ***Figure 5 shows*** the tight conditions at the shaft of the outlet structure. The gate valves in the inlet structure proved to be advantageous. Pushing the culvert pipe closed prevented further solids from settling in the blocked pipe.

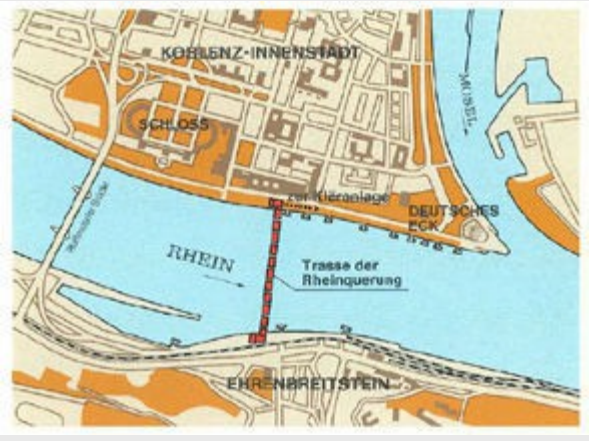

Figure 1*: Location of the culvert structure between Ehrenbreitstein and Koblenz city center*

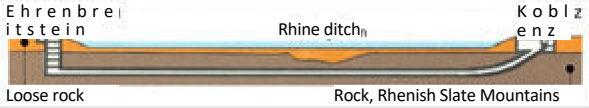

Figure 2*: Course of the Rhine culvert tunnel*

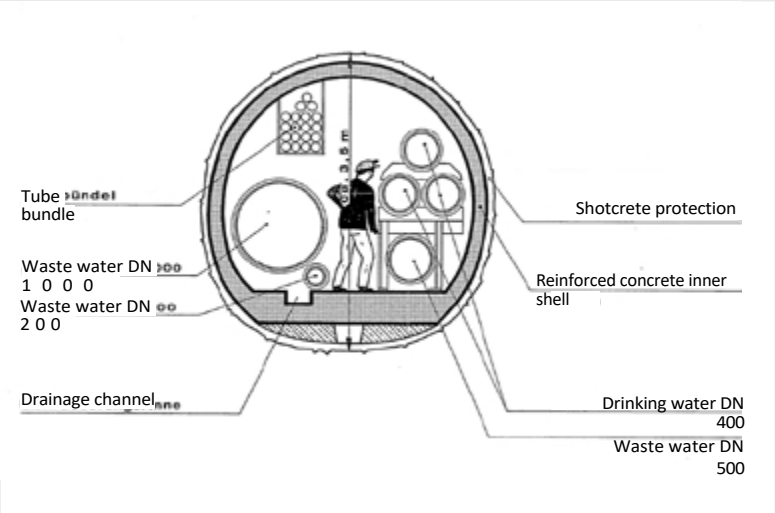

***Figure 3**: Standard cross-section of the Rhine culvert tunnel with pipes for drinking water and wastewater as well as pipe bundles for data cables*

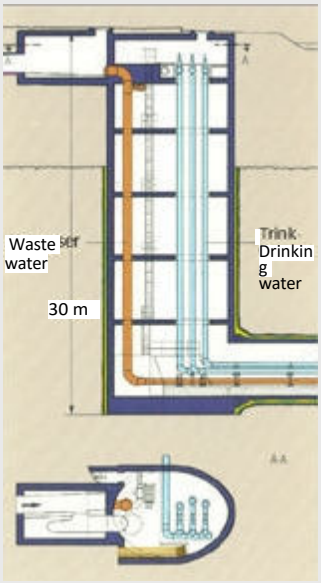

***Figure 4**: Inlet structure*

Cleaning concepts

SEK owns several high-pressure jetting vehicles. These are intended for cleaning gravity sewers. Sewers have a gradient. If deposits are mobilized, they flow out of the pipe in these sewers with the flushing water and can thus be disposed of.

The situation is different in the culvert. The pipes drop down to the low point in the culvert. Water comes through the nozzle of the flushing vehicle at high pressure, but with a relatively low flow rate. In the pipeline, this water flow is not sufficient to remove the particles.

Comprex cleaning is suitable for pressure pipes. Turbulence between air and water blocks mobilizes deposits and reliably removes them. This process has not yet been used in blocked pipes. A low flow rate is always required to create air and water blocks in the pipe. A new idea was to use the pulsed air and water blocks by to allow a kind of lance to act on the blockages. A PE pipe should be designed accordingly.

First attempts

The tight conditions at the inlet structure of the culvert only allowed small nominal diameters for the PE pipe (Fig. 5). Initial tests with a PE pipe (PE 100, 40 mm x 3.7 mm SDR11 PN16) showed that this pipe was suitable for the bend from the manhole into the wastewater pipe. This pipe could be inserted a few meters to the start of the blockage. It was stiff enough to act like a lance and direct the forces generated by the compressed air pulses from the Comprex vehicle forwards onto the blockages. Loose deposits could be mobilized and removed. Unfortunately, after initial success, the lance only made slow progress. Obviously, stuck deposits prevented progress. A different procedure was therefore required for mobilization. Once the deposits were mobilized,

***Figure 5**: Opened main shaft of the outlet structure with access and additional round closed shaft cover*

***Figure 6**: Discharged wooden parts at the entrance to the outlet structure*

***Figure 7**: Pulling out the black rinsing hose with rinsing nozzle and attached blue PE pipe as well as accumulation of adhering damp cloths and nonwovens*

the Comprex process ensures reliable discharge. As early as 2006, tests at the IKT in Gelsenkirchen showed that the impulse flushing process can even reliably remove pebble-sized stones from pipes at very low pressures [3].

The combination leads to success

There are always two steps to consider when cleaning pipes: Mobilization and discharge. The first tests on the Rhine culvert showed the advantages of both cleaning methods. The nozzle of the flushing vehicle can mobilize the blockages very well and the Comprex process can reliably remove the mobilized particles. The flushing nozzle of the flushing vehicle was therefore attached to the end of the PE pipe. A screw connection for PE pipes with rounded edges ensures that this construction does not get caught on the socket joints of the cast iron pipe. After several attempts to optimally adjust the two cleaning processes, deposits and sometimes very large contaminants were quickly removed. ***Figure 6*** shows, for example, various large pieces of wood up to 1.4 m long that were removed.

When the rinsing hose was pulled out, the adhering and other nonwoven materials on the flushing vehicle. ***Figure 7*** shows this accumulation on the one hand and the combination of the black rinsing hose with rinsing nozzle and blue PE pipe on the other.

After the concerted action between SEK and Hammann, the culvert pipe was free again. Cleaning from the bottom of the culvert proved to be advantageous. After loosening the blockage and regulating the flow velocity using the gate valves at the inlet structure, it was possible to mobilize and remove solids upstream of the blockage.

Based on the initial experience gained, further measures can be optimized. The maintenance of the culvert pipes as well as the wastewater pressure pipes is the focus of further planning by the Koblenz municipal drainage system.

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