REENGINEERING VALVE OPENING LAW TO OPTIMISE LOCK LEVELLING: SOME CASE STUDIES

by

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The hydraulic design of a lock levelling has to fulfil several criteria like: (1) short levelling duration; (2) acceptable mooring forces; (3) limited levelling wave amplitude. Usually, reducing the levelling time increases the forces acting on the vessels. In some cases, modifying the design of the levelling culverts enables shorter levelling time, through e.g. longitudinally distributed or even through equal distribution filling systems. This increased culvert complexity may nevertheless impact the building cost of the lock.

The hydraulic design usually results in an optimised design of the levelling culverts and a proposed schedule for opening the valves. During lock commissioning, the valve opening laws are implemented, tested and validated. Then, during the lifetime of the lock, it is often observed that the valve opening schedule evolves. During maintenance or replacement of electro-mechanical parts, performances and settings are not always perfectly replicated. Some technicians may adapt or tune the schedule, without refereeing to the hydraulic design team. In some cases, the reports from the original design are forgotten or even lost. As a result, the lock does not work anymore optimally.

In the last years, the Hydraulic Research Laboratory of the Service Public de Wallonie has been involved in some reengineering studies for such locks on the Walloon waterways network, Belgium. The report from these case studies will illustrate how an abnormal working process can become standard operation, and how reengineering can restore lock performances. The contribution of field measurement will also be highlighted, in the absence of extensive documentation.

A first case study covers the locks of Havré (124m x 12.5m x H 10m) on the Canal du Centre; Pommeroeul (151.75m x 12.5m x H 13.5m) and Hensies (149m x 12.5m x H4.6m) on the Canal Pommeroeul-Condé. The electro-mechanical equipment of these locks will be totally replaced in the next two years. Only partial documentation on the valve opening schedules could be recovered. Field measurements showed that the valve schedules have been significantly modified since the lock commissioning. Notably, the valves on both sides of the locks were no more synchronised. This resulted in a significantly increased levelling time.

Re-computing the filling and emptying of Havré and Pommeroeul locks with modern simulation tools also highlighted some weaknesses of the initial design. Their culverts were designed as equal distribution systems through the lock floor. It appears that the head loss distribution along the culvert components does not ensure this equal distribution of the discharge. Additionally, the valve diameter seems too large. Therefore, a constant opening rate does not ensure a proper filling: the opening is either too slow, with excessive levelling duration; either too fast, with excessive discharge around mid-opening. A complex opening schedule with different opening rates was eventually necessary to fulfil all acceptance criteria.

The second case study covers three old locks (42m x 5.15m x H 1.8 .. 2.7m) on the Canal de l'Espierres. Local staff complained about poor levelling conditions: too long valve opening schedule during filling, and too large water movement in the lock chamber during emptying. These lock are equipped with grid type valves with a very short stroke (150mm). When manual opening gears were replaced by hydraulic jacks, the opening rates of the latter was probably chosen too fast (25mm/s). An accurate control of the valve opening and of the levelling process is therefore difficult. Nevertheless, re-computing the filling and emptying process enabled to propose more adequate valve schedules.

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