Paper 58 – The Seine-Scheldt project Challenges renewing the lock of Harelbeke

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ABSTRACT: Within the Seine-Scheldt program, the river Lys is prepared for 4500-tons vessels in order to connect the Paris region with the Antwerp-Rotterdam region. One of the main challenges is the construction of a new lock in the city centre of Harelbeke. A project with a short execution time, a lack of space of the project area, obvious need to continue the water discharge and the vessel traffic during the works, … : a nice cocktail of boundary conditions which make the works more complex, technically difficult and expensive. Thanks to the right design choices and a detailed phasing, this was made possible.

1 INTRODUCTION

The Seine-Scheldt project aims to connect the Seine basin in the Paris region with the Scheldt basin in the region of Antwerp-Rotterdam, for vessels up to ECMT-class Vb (4500 tonnes). In order to achieve this, the Belgian region of Flanders is executing navigability enhancements of the river Lys, which currently allows vessels up to 2000 tonnes.

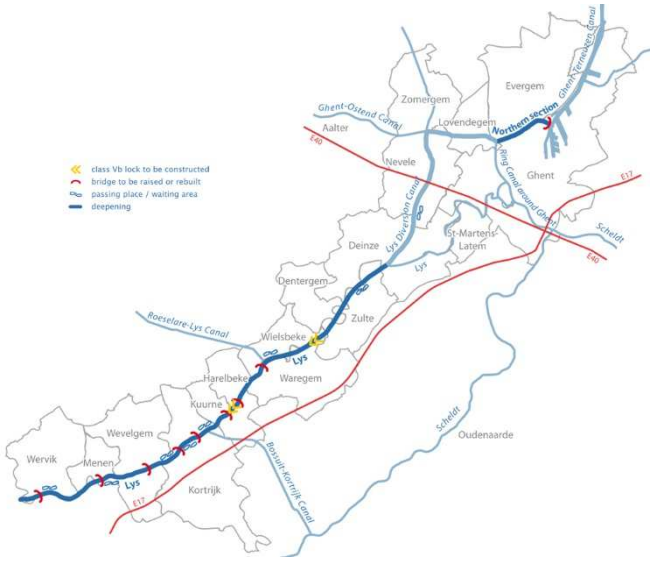

Figure 1: Adaptation of the River Lys

One of the main challenges for this calibration lies in the construction of a new lock in Harelbeke, to replace the insufficient existing one. Therefore, the reconstruction of the lock and its interconnected weir, and simultaneously the reassessment of the urban site with its waterfront and its two bridges, becomes an important goal for the Seine-Scheldt project.

2 TENDERING METHOD

Based on the project scale, the number of constructions to be built, the challenge of continuity of vessel traffic and water discharge during the works, not the classic design approach was chosen.

The goal was to speed up design time, to obtain the state-of-the-art solutions for the technical challenges and to get an integrated design with minimized risks.

In order to achieve an integrated project that offers this best fit solution, the waterway manager "Waterwegen en Zeekanaal nv" decided to launch a "Design & Build" procedure (D&B) for the project in Harelbeke.

A 3-step tendering procedure was carried out, starting with the call for candidates in December 2010. The 7 selected candidates received the contract specifications with a detailed list of requirements in May 2011 and were invited to lay down their first offer by October 2011. At this stage the evaluation criteria focussed on spatial quality, technical feasibility, and of course hydraulic and nautical merit.

The candidates that submitted the best 3 tenders were invited to further detail their conceptual design. The second offer also had to focus on the aspects of nuisance during execution, durability of the design, planning and overall management. All of these aspects were of minor importance in the assessment of the first offers but gained weight in the second phase.

The third and final offer was the moment of truth: after one year of focussing on quality, the price had

to be laid down in October 2012, counting for 40% of the total evaluation criteria.

The design of Leie|Land, the winning contractor, proved an integrated approach of the design with respect for all project details and, most important, minimization of risks.

In order to achieve this, a temporary lock and a temporary weirs are proposed. This way, the same level of protection against flooding and a comfortable navigation is guaranteed during construction.

The project cost is 98 million euros with an execution time of 30 months.

3 PROJECT DETAILS

3.1 *Lock and weir*

The most important goal of this project is the replacement of the existing lock for vessels up to 2.000 tons by a new lock for vessels up to 4.500 tons (ECMT-class Vb). The new lock chamber will be 230 m long by 12,5 m wide. There will be three lock heads with interchangeable steel miter gates. The middle gates serve a double goal, not only to create a smaller lock and saving water when levelling a smaller vessel, but also as active spare gates in case of any problem with the upper or lower lock gates. As all gate pairs are interchangeable, a replacement operation is made rather easy.

Based on the lack of space and the limited drop, no side culverts are installed but culvert openings in the gates are provided. Opening and closing is realized by operating a vertical lift valve. In order to limit the flow impact on the vessels, steel bars are installed downstream of the culvert openings to break the energy.

The existing weirs, two redundant constructions with vertical gates and a width of 12,5 m each, will be replaced. The new gates will be 12,5 m wide as well and will have tainter-gates with an upper flap.

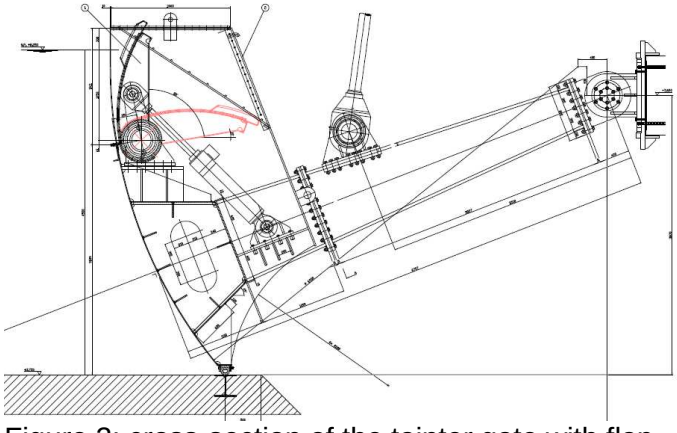

Figure 2: cross-section of the tainter gate with flap

Only one gate is needed for the water flow up to 200 m³/s, but because of safety and redundancy reasons, a second gate was required.

3.2 *Fish passage*

In execution of the European legislation concerning fish migration, a fish ladder will be built next to the weirs. This construction counts 21 V-shaped steps with a difference of 10 cm, which allow fish to migrate between the two river basins which are separated by the lock and weirs.

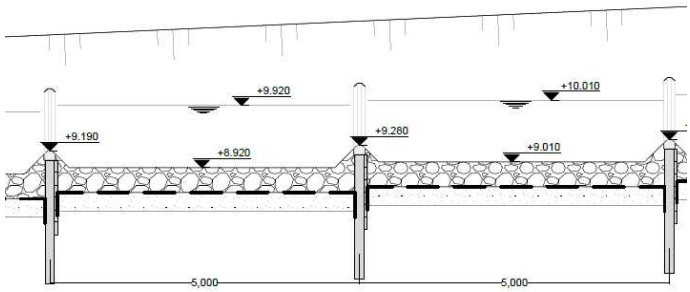

Figure 3: cross-section of the fish passage

3.3 *Pumping station + hydro-energy*

To enable continuity of vessel traffic during dry periods, this project integrates a pumping station. The two pumps are able to compensate the water losses when shipping vessels through the lock. Combined with this installation, the construction is able to generate electricity when using the pumps as water-power-plants. With only a drop of 2,10 m, this lock will be energy-neutral on a yearly basis.

3.4 *Bridges*

One bridge will be renewed as the clearance under the bridge was insufficient for vessels with 3 layers of containers. The design of this bridge is a nice steel bow-bridge, linked with the classical bow-bridges across the river Lys.

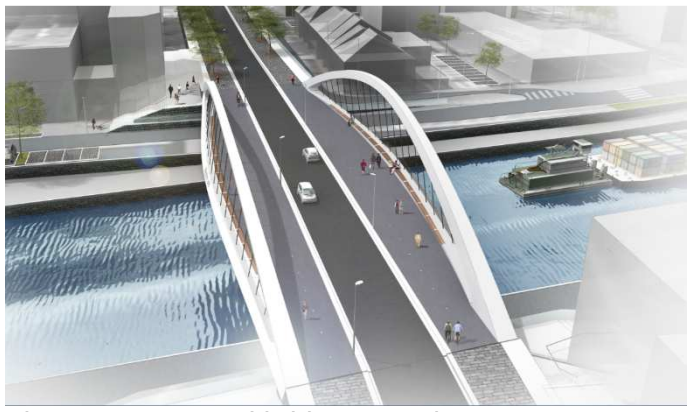

Figure 4: New road bridge "Hogebrug"

The large walkways next to the road are nice terraces above the water with ship-like teak banks at the sides. The surroundings of this bridge will be adapted to the contemporary atmosphere of the bridge design with pedestrian areas in contact with the water level, functional and accent lightening.

Another bridge, further away from the city center, will be raised by 40 cm to reach the necessary clearance.

3.5 *Mill island*

The old mill island, with two classified old mill buildings driven by water energy, lost contact with the water. The old river branch was cut and the connection between one mill and the river was filled up.

To rehabilitate the heritage quality of this site, the old river branch will be restored and the mill will be reconnected with the river by constructing the so-called "intake". A new fixed bridge will connect the island across the new intake while a new turning bridge across the river will connect the mill island to the city center.

The existing abandoned mill building will be restored and will host offices and lofts.

As the tip of the island will be a park zone, the rest of the island could be intended for other buildings, a marina or other functions.

Figure 5: view on the future mill island

3.6 *Surroundings*

As this project is embedded in the city center, a lot of attention was drawn during the design to highlight and upgrade the river surroundings. All the roads on the river banks will be renewed, a lot of new trees are integrated in the design, and the finishing of the quay walls are city-adapted. The quay walls will be covered with nice basalt brickwork.

Together with this works, the city of Harelbeke decided to upgrade the city center itself. The market place will be faced again to the river, after breaking down two buildings in between. The river banks next to the market place will be widened in order to organize the weekly market on the river banks and reconnect the city to the river.

3.7 *Adaptation of the river Lys*

To prepare the river for the longer, higher, deeper but also more powerful ships, the river has to be dredged and provided with scour protection next to the quay walls, lock and weirs.

4 PHASING OF THE WORKS

4.1 *General*

The winning design planted the new lock on the same spot as the existing one because of spatial boundaries and the optimization of nautical access.

As mentioned before, a temporary lock and weirs are necessary to minimize risks of flooding and to continue the vessel traffic when the existing infrastructure is out of service.

Smart design options generated a feasible building cost by reusing spare parts of the actual lock and reusing parts of the temporary lock and weir in the final constructions.

The following paragraphs show the detailed phasing of the works in order to be able to build these constructions on a reduced building space.

4.2 *Phase 1: preparation*

The tip of the mill island is prepared for the execution of the works.

Both blue arrows show the water discharge through the weirs, the green arrow shows the traffic through the lock.

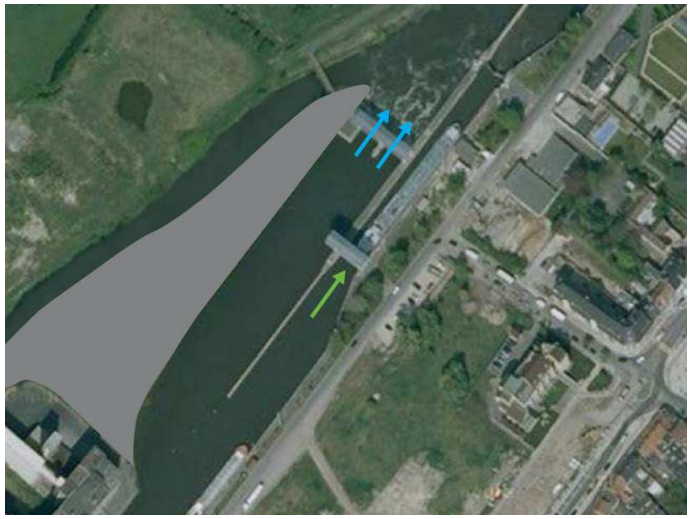

Figure 6: Preparation

4.3 *Phase 2: temporary weirs*

On the mill island, the temporary weirs are built. These weirs have the same dimensions of the actual and future weirs in order not to increase risks of flooding. The old branch of the river has to be deepened and protected for the flow up to 200 m³/s.

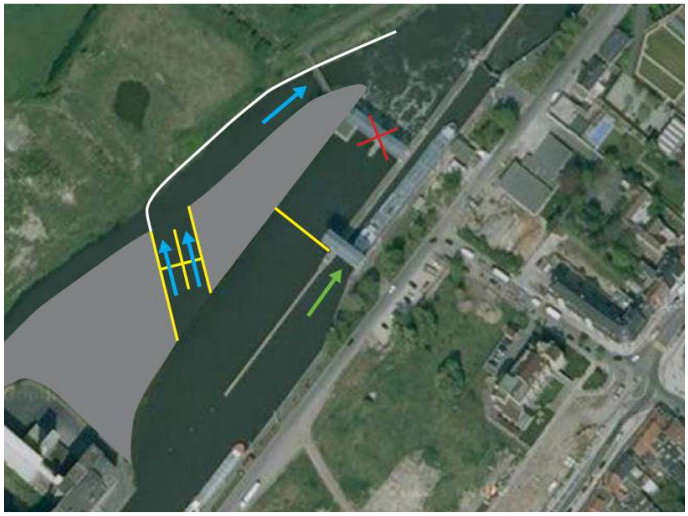

Figure 7: Temporary weirs

Once the temporary weirs are in use, the existing ones can be demolished in order to get space to build the temporary lock.

Before breaking down the existing weirs, the wall of the lock chamber has to be stabilized to prevent deformations or settlements.

4.4 *Phase 3: temporary lock*

The temporary lock is built in the middle of the river and has the same dimensions as the existing lock. The lock is composed of easy-to-remove parts to facilitate the demolishing works.

The lock heads are massive concrete constructions, able to withstand the forces from the miter gates and water pressure.

The lock chamber walls howerever are composed by combiwalls (steel sheet piles combined with steel piles), finished with prefabricated concrete slabs to form typical concrete lock walls. This innovative construction method reduces the construction time for the entire lock to 8 months.

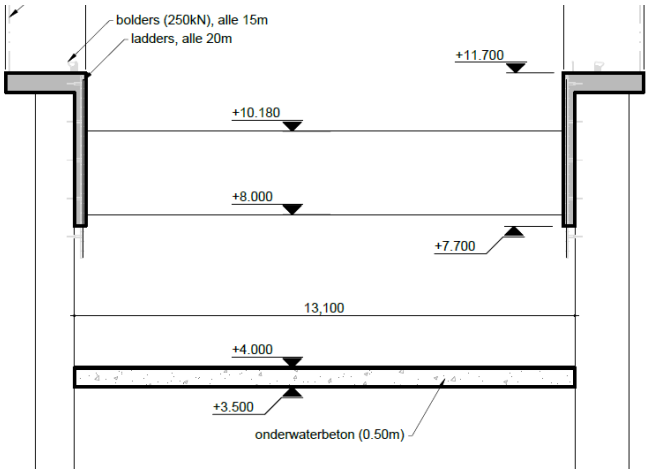

Figure 8: Cross-section of the temporary lock

The upper lock head (yellow block on figure 9) uses the spare miter gates and machinery of the existing lock while the lower head gates (white block) use the future gates of the middle lock head of the future lock. This approach reduces building cost and uses the available components in a durable way.

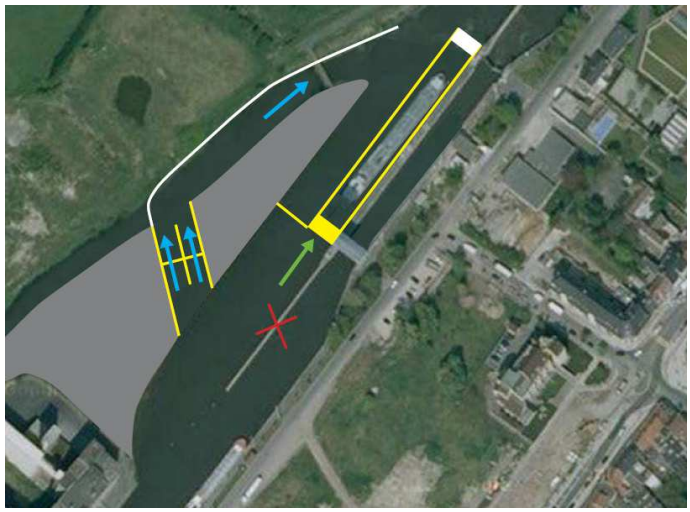

Figure 9: Temporary weirs and lock

Detailed study and calculation of all the situations during these phases was needed to guarantee stability of the temporary and final sheet pile walls during the works.

4.5 *Phase 4: New final lock*

Only once the temporary weirs and lock are in use, the renewal of the existing lock can start.

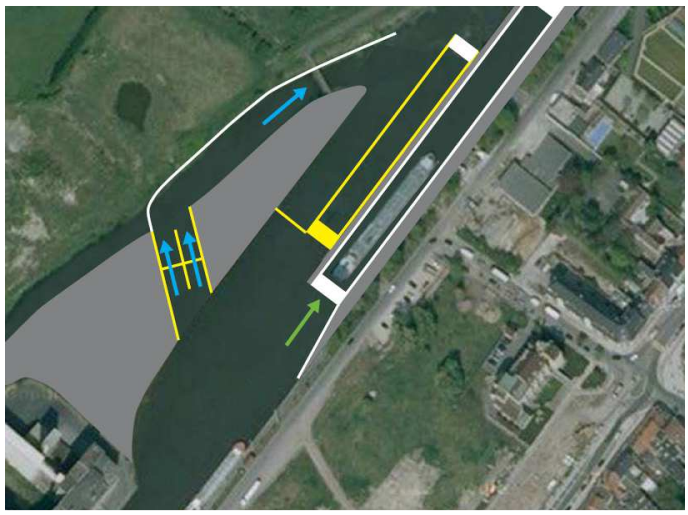

Figure 10: New lock

As the construction works are executed between the lock in operation and the lock operator building, special measures have to be made to keep sight on the lock for operation and to give access for shippers to go to the lock operator building.

The existing lock building is positioned on the new lock walls, so the building has to be renewed as well.

Operating all temporary and final constructions with different operating facilities from only one operator desktop urges the contractors to prepare and design operating programs with all future constructions and locations in mind. The switch between temporary and final constructions must be made easy for the lock operators to avoid operation mistakes.

4.6 *Phase 5: New weirs and pumping station*

Once the new lock is in use, the temporary lock can be taken out of service and the new weirs and pumping station can be built on this location.

During this phase, the downstream doors of the temporary lock will be positioned and adjusted in the middle head of the new lock. This is in fact the only moment where vessel traffic has to be stopped during a few days!

The steel tainter gates of the temporary weirs are reused in the new weirs. They have to be installed one by one to guarantee continuous water discharge. Also the hydraulic and electrical installation are reused, only the concrete construction of the temporary weir will be lost.

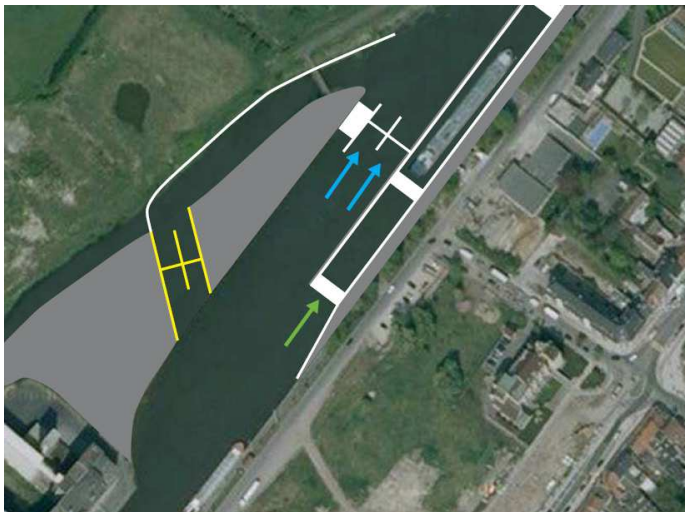

Figure 11: New weirs and pumping station

4.7 *Phase 6: Fish passage*

After only 30 months of execution time, this is the end of the project. The new lock and weirs are in use and after breaking down the concrete structure of the temporary weirs, the fish passage can be built on this location. On the upstream end of the fish passage, three vertical lift gates will be installed to regulate the water flow through this connection.

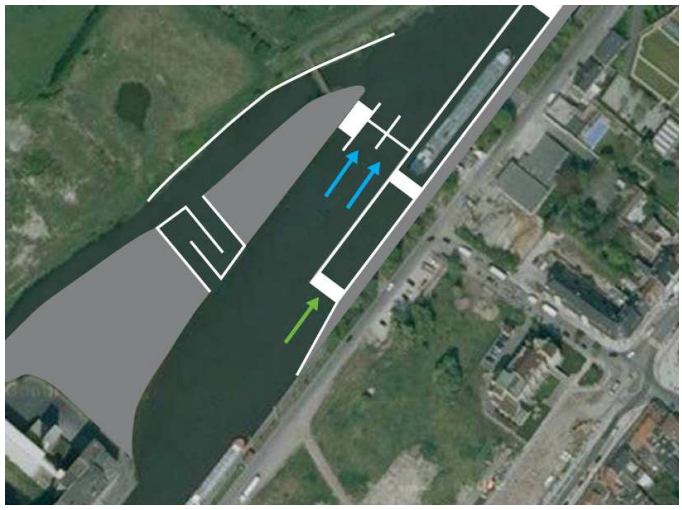

Figure 12: Fish passage

5 STATE OF AFFAIRS UNTIL MID 2015

Road bridge: the old bridge was broken down, the abutments of the new bridge are under construction and the parts of the steel bridge are almost finished. These bridge parts will be shipped to the site and welded together on the spot.

Lock/weir: phase two, the temporary lock is built and taken into service in august, the preparations for the temporary lock are made.

6 DIFFICULTIES/LESSONS LEARNED

6.1 *Project boundaries*

When the design exceeds the project limits, even underground for soil anchors stabilizing the quay walls, this has a major impact on the project timing. When additional terrains are needed, the project timing is often too short to be able to start procedures to buy or expropriate those necessary terrains. This aspect should be taken into account when evaluating designs, not only because of the project timing but also because of expropriation cost and fair comparison between different offers.

The assessment should be made if the expropriation is a possibility or an alternative design within the project limits should be made. The correspondent timing and cost could then be taken into account in the evaluation of the several offers.

6.2 *Project surroundings*

Most of the attention goes to the evaluation of the design of the necessary constructions. While evaluating the several offers, the adaptation of the design to the surroundings should get sufficient attention as well. Hidden problems could create unexpected discussions as well as costs and exceeding execution time. As obvious as it may seem, a good and detailed tender document still is the best basis.

6.3 *Design changes*

As the design is the responsibility of the contractor, redesigning several details just before or while constructing is possible. More than in the classic contracting methods, the Design and Build procedure leads to frequent mixing of design and execution phases. Sufficient time is needed for the founder to check if the design still meets the principal requirements.

7 CONCLUSION

With the Design and Build procedure for renewing the lock of Harelbeke and its surrounding works, Waterwegen en Zeekanaal launched a new contracting method to get an integrated solution for the difficulties within the design.

Not only the lock will to be renewed, also weirs, bridges, quay walls, new roads and surrounding works complete the list.

The winning contractor came up with a well-considered design, providing a temporary lock and weirs to guarantee flood protection and vessel traffic during the works. A downtime for the lock of only a few days is the result.

With an execution time of only 30 months for this project, yet another step in the Seine-Scheldt project is made.