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Fig.1: Lanaye Lock Complex – © JL DERU / photo-daylight.com

Summary

Study and construction of a Vlb class lock, length 225 metres, width 25 metres and head 13.70 metres, a road bridge 210 metres long and 15 metres wide, a road tunnel 150 metres long, a pumping station/hydro-electric power plant and a collection of additional works within an operating lock complex (2011-2015).

Origins and development of the Lanaye lock complex

The lock complex is located on the border between Belgium and the Netherlands to the north of the town of Visé. It provides a direct link between the Albert Canal and the Dutch Meuse and is part of the priority European project for a corridor connecting the North Sea to the Black Sea (TEN-T project No18) via the Rhine, Main, Danube and various interlinking canals.

The complex was built in the 1930s at the same time as the Albert Canal and at that time comprised two locks of 55 x 7.5 metres accommodating 650-tonne vessels. A further lock, measuring 136 x 16 metres, was built in the 1960s to take 3,000-tonne vessels. During the 1980s, major widening works took place on the Albert Canal so that it was navigable by convoys of up to 9,000 tonnes.

In 2002, SOFICO, through its contracting authority (SPW – Liège waterways directorate), awarded the contract for the design of the civil engineering and associated electro-mechanical works to the temporary consortium made up of GREISCH, for the civil engineering part, and SNC-LAVALIN for the electromechanical part (to be later sub-contracted to Tractebel Engineering).

Fig.2: Aerial view with approximate border between Belgium and the Netherlands – © SPW

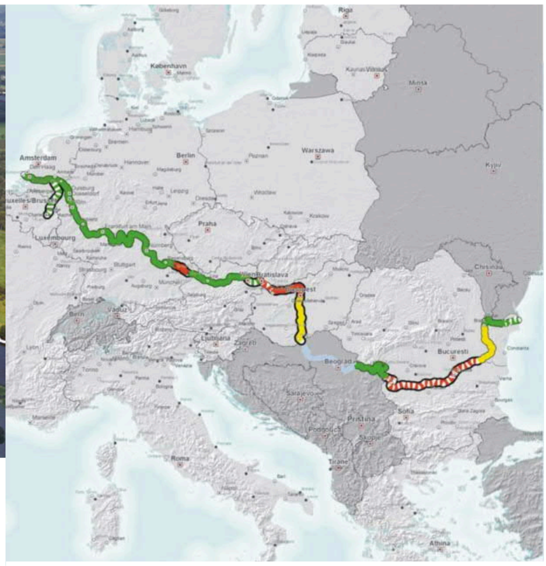

Fig.3: TEN-T Network Project nr 18: Rhine/Meuse – Main – Danube – © EC–TEN-T– © SPW

The fourth lock

The fourth lock at Lanaye is a major undertaking aimed at improving the performance of the river infrastructure in Wallonia to allow convoys of up to 9,000 tonnes to navigate between the Dutch Meuse and the Albert Canal. Part of the new construction is on Dutch territory. Over the next years though, according to the effective widening of the locks in the Netherlands, the new infrastructure will mainly be devoted to operating the navigation of a pair of simultaneous 4,500-tonne vessels. The three existing locks will remain in operation for smaller boats.

The new lock, measuring 225 metres long by 25 metres wide, carries boats over a lift of 13.68 metres. The geology of the Lanaye lock site is made up of canal bottom silt on watertight puddle clay between 55.00 and 53.00 m, alluvial silt between 53.00 and 47.00 m, sand and Meuse gravel between 47.00 and 42.00 m, weathered chalk between 42.00 and 37.00 to 27.00 m, then sound chalk. The head of the lock generates significant hydraulic gradients through those layers, with consequence that all the major works have been designed taking account the hydrogeological and geotechnical risks: underground flows, hydraulic pressure, water tightness, retaining effects. A surrounding enclosure of cut-off trenches was created around the lock chamber.

Given the nature of the lock's foundation soil, it was necessary to construct a 2.50-metre-thick structural raft. The aqueduct walls, set into this raft, are 2.50 metres thick and topped with 3- metre-thick slabs into which the chamber walls are set. These walls vary in thickness from 3 metres at the base to 2 metres at the top.

There are no expansion joints anywhere on the structure, this choice avoiding the problem of watertight joints which are difficult to execute and have a short life. Additional reinforcement is foreseen to prevent subsequent concrete cracking. An effective drainage system comprised of drainage ditches and a drainage blanket was made under the whole of the foundation raft and is connected to the downstream reach via a peripheral drain on roof of the culverts (plus a transfer and inspection pit). This system provides better control of the uplift pressures beneath the lock and reduces the stress exerted on the raft.

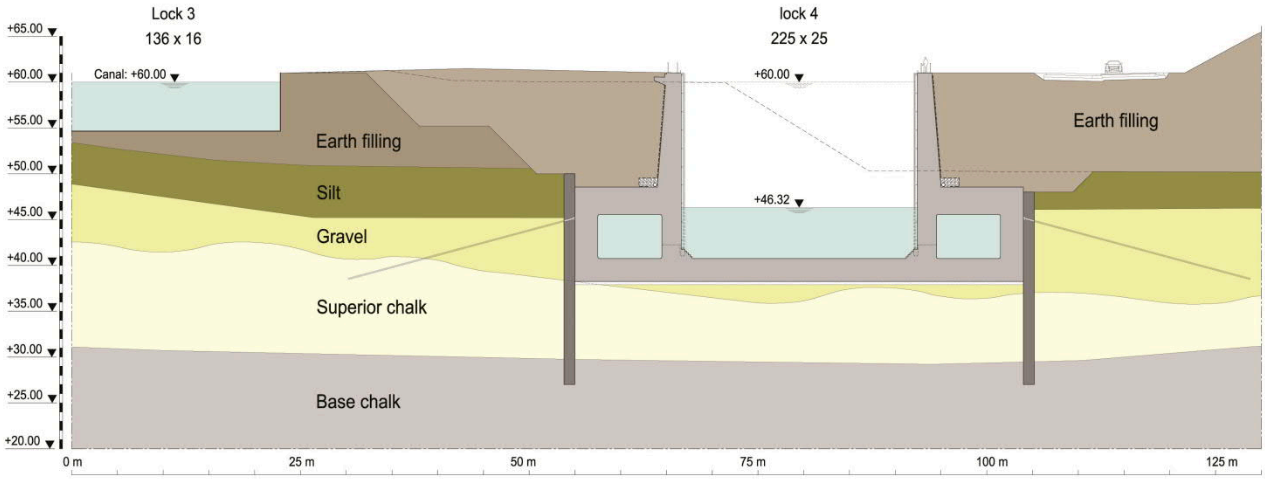

Fig.4: Typical cross section – © Greisch

The gates

The upstream lock gate is an 80-tonne steel flap, while downstream head is equipped with mitre gates comprising two 135-tonne half-gates. Those types of mobile structures were chosen together with the hydraulic department of the Public Administration, considering various criteria (robustness, overall weight, maintenance, design of the lock heads, ...).

Fig.5: Upstream flap gate – © Greisch

Fig.6: Downstream mitre gate – © JL DERU/photo-daylight

The pumping station

The installation of this new large lock leads to greater water consumption. The amount required to fill the new lock is 80,000 cubic metres. This very large volume of water is taken from the Albert Canal, which in turn draws its water from the Meuse. In order to avoid ecological and environmental problems when water levels are low, a pumping station balances the equivalent of the average water consumption of the locks back into the Meuse. This pumping station is almost entirely beneath ground level. It also houses five turbines for producing green electricity when the Meuse is flowing sufficiently, in order to offset the site's annual power consumption.

A new bridge

The new bridge downstream spans the exit reaches of the four locks (with bays of 26, 56, 72 and 56 metres respectively, from the right bank to the left). It is a composite steel-concrete construction comprising a metal box girder 6 metres wide and 2 metres high, topped with a reinforced concrete slab of 35 cm thickness. The slab, total width 15 metres, has two 4.5-metre overhangs.

A box-girder design was necessary on account of the limited available height and curved alignment of the bridge giving rise to high torsion. These torsional forces are transferred fully to the abutments to reduce the presence of piers and free up the mole and other supporting zones. This gives the bridge a lightness of appearance in contrast to the backdrop of the massive downstream heads of the locks.

Fig.7: Downstream view – new bridge – © JL DERU/photo-daylight

Other structures

A new control station has been built between the two larger locks to give operators a better view from their desks in their elevated, fully-glazed control room.

New quay walls have been constructed on either side of the lock over a total length of 1,500 metres. The upstream wall is an extension of the widening works from the 1980s. Downstream, the wall separates the Lanaye Canal from the Old Meuse, which is a protected natural site. It has a variable height coping, making it easier for crew to disembark depending on the water level.

A 140-metre tunnel links the public highway to the towpath sited 10 metres below. It also has an important role as a support between the lock complex and the protected Old Meuse.

These major works also include landscaping and renovation of the lock buildings and gate operating machinery of the old locks, aimed at improving their appearance and integrating them into the landscape.

The works

Major excavations were required for building this new lock, calling for large supporting structures and high embankments. A completely sealed enclosure was created with diaphragm walls and tension ties so that work could be carried out in the dry.

Fig.8: Overall view during excavations– © JL DERU/photo-daylight

The pumping station called for deeper excavations, protected by a surrounding enclosure of diaphragm walls which were stayed as the excavation advanced. During these works, the structure acted as a support over a height of 22 metres.

More than 220,000 cubic metres of concrete was needed for all the works. Most of it was produced in a ready-mix plant installed on site, with aggregate taken from the spoil after washing, crushing and screening.

The excavations generated 1,200,000 cubic metres of spoil. The excess, around 625,000 cubic metres, was taken to a fill site in the Albert Canal at Lixhe.

Fig.9: Construction stage of the lock chamber– © JL DERU/photo-daylight

The works started in July 2011. The investment of 120 million Euros ex-VAT for the civil engineering works, and 30 million Euros for the electromechanical works is supported by the Region of Wallonia, a loan from the EIB (via Sofico), European subsidies (TEN-T for 30 million Euros) and by the Netherlands (9 million Euros). The civil engineering works were carried out by BESIX and the electromechanical works by the temporary consortium SPIE-FABRICOM-SANOTEC-BALTEAU. The fourth Lanaye lock entered service on 6 November 2015 and was officially inaugurated by His Majesty King Philippe on 13 November 2015.

The operation

The whole sluice complex is successfully operated since March 2016. Inland navigation is significantly improved due to the large capacity of the new lock.

Concerning the structures, local maintenance and repair was needed due to some specific site parameters (height of earth filling, wave effects along the hydroelectric culvert, bollard anchorages, …)

Oral presentation focusses on design challenges, main construction stages and first experiences after a 3 years operation phase.

Pictures (sub-texts and credits)

1. Aerial picture of Lanaye Lock complex – ©JL DERU / photo-daylight.com
2. Overall view of the lock site and approximate shape of the border – © Service Public de Wallonie (SPW)
3. TEN-T Network Project nr 18: Rhine/Meuse – Main – Danube – © European Commission Website
4. Typical cross section of the 4th lock – © Greisch study office
5. Upstream flap gate – © JL DERU / photo-daylight.com
6. Downstream head and its open mitre gate – © JL DERU / photo-daylight.com
7. Downstream view – new bridge – © JL DERU/photo-daylight
8. Overall view during excavations– © JL DERU/photo-daylight
9. Construction stage of the lock chamber– © JL DERU/photo-daylight