Lievense

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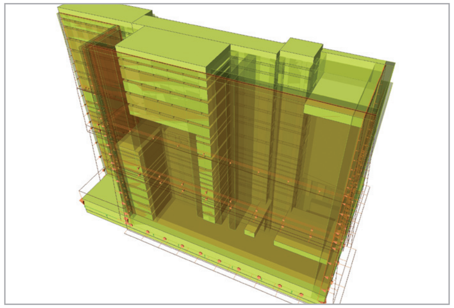
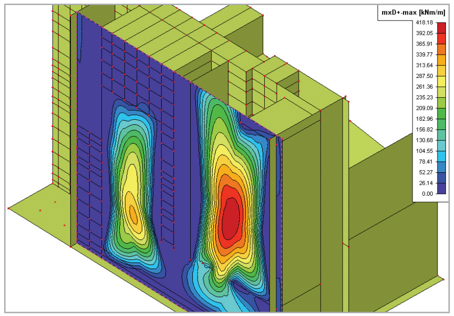
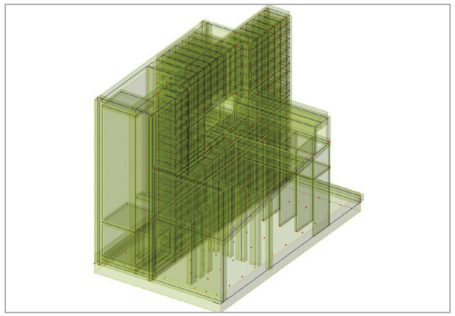
Lievense is an international consulting engineering agency, founded in 1964, and active in preparation, realisation and monitoring of infrastructure. We are specialised in: Harbours and fairways; Locks; Water-retaining & water-management; Civil structures; Pipelines; Pipeline integrity.

We help our clients to realize their goals, as effectively as possible within the present complex society, in a sustainable and responsible way and within the limits of time, budget and quality. The focus of Lievense is durability in everything we do. Doing state of the art work and taking into account the flexibility that organisations need for their business. Environment is another essential part in the way we work to achieve success. Here, we also see great opportunities: the "Energy Island" and the "Nieuwe Afsluitdijk" (New Dam) are just two examples that we are excited about. Where wind and water are abundant in the Netherlands, we at Lievense have built up a long standing experience. Durability and innovation is what characterizes Lievense, which is our way to continue working on a future for people and society. Engineering the future is our motto.







Software: Scia Engineer

New Upper Lock Head - Born, The Netherlands

The Meuse inland water transport fairway is being upgraded to accommodate vessels up to class Vb. The navigation locks at Born, Maasbracht and Heel consist each of several parallel lock chambers stemming a maximum water level difference of 12 m. At each complex one lock chamber is extended from 140 m to 225 m length. The other lock chambers, including gates, slides and driving equipment are renovated.

Lievense prepared the tender design for Besix-Mourik, who won the D&C contract. Lievense's next tasks included the preparation of final and detailed designs and risk analyses for them.

The lengthening of lock chambers includes the construction of new concrete lock heads and lock chambers, reconstruction of old lock heads and rearrangement of the outports.

Description of the project

The upper lock head of lock Born is built up of approximately 6.200 m^3 of reinforced concrete and consists of the following components:

- Floor of reinforced underwater concrete
- Walls of reinforced concrete in which the culverts and valve shafts are situated
- Intermediate floor of reinforced concrete which forms the roof of the stilling basin
- Stilling basin underneath the gates, provided with columns and walls to break the water flow
- The sill is constructed as a tubular hollow section girder of reinforced concrete for the transit of cables
- Steel lock gates
- Foundation consisting of 140 GEWI-piles which can both take tensile and compression forces.

Approach

The upper lock head has to resist up to 18 m of soil pressure on the outside and variable hydraulic loads at the inside of the structure. The upper lock head appears to be a massive structure with walls up to 7.1 m thick. But due to the presence of several compartments (e.g. the culverts and intake are located in the walls), they could not be modelled by a single 2D element. And modelling of the walls by just one 2D element would result in a too large span of the floor. Therefore, the walls have been modelled by several cooperating 2D elements (membranes and shells). In order to determine the flow of forces through the thick walls around the hollow spaces, a "framework" of more then 160 membranes and shells have been used.

The tubular hollow section girder functions as a prop between the walls of the lock head. Besides, forces will be transmitted between walls and floor via this girder and the walls underneath it.

The use of Scia Engineer for this project

The lock head has been modelled in Scia Engineer. Only half the structure has been modelled since the lock head and the horizontal loads on it are symmetric to the axis of the lock. The connection with the other half of the structure has been modelled by supports.

For the outside 2D elements of the walls, shells have been used, since perpendicular to those elements loads are acting. The intermediate 2D elements are membranes, modelled as orthotropic 2D elements with very small plate rigidities. The total moment of inertia of all those shells and membranes is kept equal to the moment of inertia of the real wall by adjusting the thicknesses of the elements. The internal forces in the walls have been determined by means of resultants on sections across the walls.

All other concrete and underwater concrete elements have been modelled by just one 2D or 1D element. The GEWI-piles have been modelled by linear springs.

The model in Scia Engineer has been used to check the stability and strength of the structure in the final stage and to get an indication of the deformations.

With the model the favourable 3D effect of the tubular hollow section girder, including the walls underneath and the columns between the underwater concrete floor and the intermediate floor on the internal forces in the underwater concrete floor became more evident. Also the degree of support of the walls by the tubular hollow section girder could be determined.

The maximum uplift force on the underwater concrete occurs during the building stage, when only the floor and piles are present. This stage has been considered by a second model in Scia software.

New Upper Lock Head

Born, The Netherlands

Project information

Owner	Rijkswaterstaat Maaswerken
Architect	Rijkswaterstaat Maaswerken
General Contractor	Combinatie Besix-Mourik
Engineering Office	Lievense
Construction Period	From May 2010 to August 2011
Location	Born, The Netherlands

Short project description

The upper lock head of the Born lock is built up of approximately 6.200 m^3 of reinforced concrete. In the walls, which consist of reinforced concrete up to 7.1 m thick, the culverts and valve shafts are situated. The reinforced concrete intermediate floor forms the roof of the stilling basin. In the stilling basin underneath the gates columns and walls are provided to break the water flow. The sill is constructed as a tubular hollow section girder of reinforced concrete for the transit of cables. The steel lock gates retain the water. The maximum water level difference over the steel lock gates is 11.25 m.