THE PORT OF OSTEND: CONSTRUCTION WORKS FOR THE WIDENING OF THE INNER APPROACH CHANNEL

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EXTENDED ABSTRACT

The widening of the harbor approach channel inside the harbor of Ostend concerns the last phase of the works in the framework of the 'Integrated Coastal and Maritime Plan for Ostend'. One of the objectives of this plan was to make the harbor of Ostend accessible for ships with lengths up to 200m. Previous works related to this objective included the construction of two new breakwaters and the relocation of the outer approach channel, allowing ships to enter safely into the harbor.

At present the approach channel in the harbor of Ostend is enclosed by a timber pier at the western side, and a seawall with the harbor site 'Halve Maan' at the eastern side. As the timber pier is protected by law as heritage (Figure 1), extension of the channel is only possible at the eastern side.

In 2015 navigation simulations were performed with different vessels (cruise-ships, RoRo-ferries and cargo-ships) to optimize the design of the inner channel (Figure 1). It was concluded that the inner channel should be widened from 80m to 125m at the most northern point of the site 'Halve Maan' to 145m at the most southern point of the site 'Halve Maan'. As the northern part of the site is part of a habitat directive area, the occupied space must be limited as much as possible and a nature compensation is required.

The design wave conditions at the location of the new construction were determined by numerical simulations. Further an extensive soil investigation at the site 'Halve Maan' was performed (exploratory trenches, CPT testing, boreholes and laboratory testing). Due to the interference between nature, infrastructure and exploitation zones, the works were split into three main project areas (Figure 1): north, middle and south. A site-specific design was developed for each of these zones.

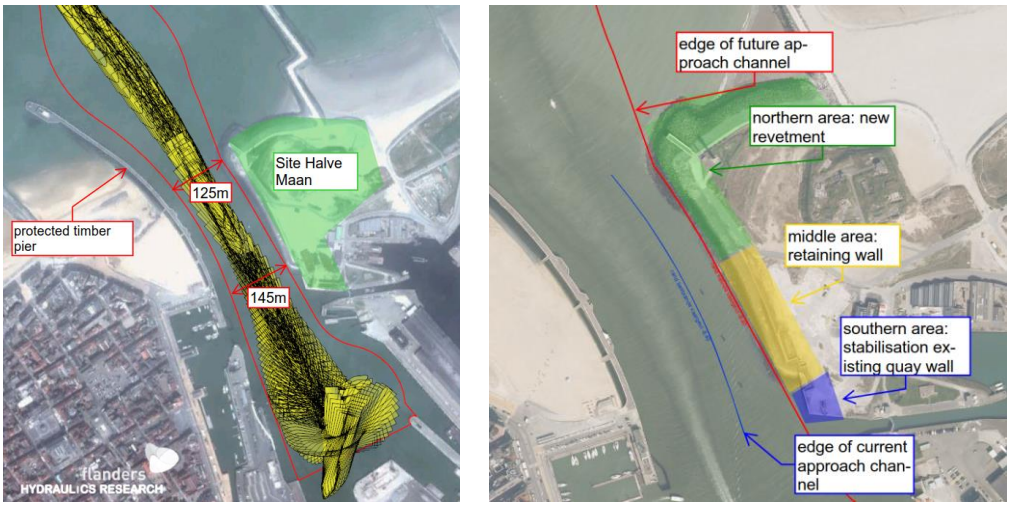

Figure 1: navigation simulation with widened approach channel and definition of project zones

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For the northern project area there is a geometrical constraint related to the present habitat directive area. Therefore, instead of simply shifting landwards the existing seawall, a structure with a steeper slope was designed. The northern zone is oriented towards the harbour entrance and hence exposed to significant hydraulic loading. In this area, a protection using concrete HARO blocks (weight 15 tons) was designed to resist significant wave heights up to 4m. The height of the seawall is limited to achieve an economically (less earthworks) and environmentally (minimize use of habitat area) acceptable design. Obviously, this results in significant overtopping in extreme conditions, which means that the landward side of the seawall also has to be protected with armour stone to prevent backward erosion of the revetment.

The middle project area is located near an existing exploitation zone used by the offshore industry. Intended as a handling area for heavy windmill components, pavement of a large part of this exploitation zone was designed for a uniform load of 10t/m² using deep foundation techniques. Geotechnical conditions for this area are quite challenging with soft soils (clay, peat) up to depths of 15m. Based on the above, shifting the existing seawall landwards was considered not expedient and as an alternative a quay wall was designed. The quay wall consists of a heavy combi-wall (tubular piles as primary unit and intermediate double AZ sheet piling) with inclined ground anchors (pre-stressed grouted anchors). To avoid interference with the existing deep foundations of the pavement area, the anchors have to be positioned quite vertically: resulting inclination angle is 60° with the horizontal. Due to this inclination, combined with the poor geotechnical conditions, design anchor loads were quite high with service loads up to 165 tons. Since anchor service load is high and inclination is quite vertical, an extensive full-scale testing programme is foreseen to validate the design loads for these ground anchors.

In the southern project area, the existing seawall ends in a quay wall. This quay wall of the Danish type has to be preserved, as it is the loading area for the offshore exploitation zone mentioned in the previous paragraph. Since the widened channel comes quite close to this existing quay wall, a solution had to be found to reinforce the quay wall and allow for an increase in depth. Modifications to the existing quay wall were considered too complex, and preference was given to less invasive solutions. Since the main issue was an increase in depth at a certain distance from the quay wall, but within the passive wedge, it was decided to build a gravel berm in front of the quay wall. Using this berm made it possible to avoid an increase in bending moment in the retaining wall, and allowed for sufficient earth resistance (passive earth pressure in front of the wall). However, for the corner section of the quay wall the widened channel comes so close to the quay that a simple berm proved to be insufficient to provide the required degree of safety with relation to ground failure. The design was developed further to take the 3-dimensional spatial distribution of soil pressures into account. Nevertheless, an additional reinforcement was necessary, and it was decided to increase the passive resistance by construction of vertical gravel columns in front of the retaining wall.

As the works cover a range of challenges related to building into an existing harbor with limited space and many boundary conditions, the project is a typical example of modern day port expansion works. It is demonstrated that it is possible to realize this type of project successfully, but a significant design effort is necessary to fulfill all stakeholder needs in agreement with all site-specific requirements. Construction works will start in 2018 and should be finished in the course of 2020. When the envisaged works are finished, the last phase of the masterplan for the port of Ostend will be completed.