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# PORT OF ZEEBRUGGE: LARGE PHYSICAL MODEL TO STUDY ACCESSIBILITY AND SILTATION

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## 1. Introduction

The port of Zeebrugge (Figure 1) is the second largest port in Belgium and the fastest growing of the region. Despite the efforts of the Flemish Government in deepening the navigation channel and the outer port, the access for tall ships is limited to a narrow inbound sailing window due to strong flood flows in front of the port entrance. Another specific problem of Zeebrugge is the rapid siltation which requires continuous dredging activity.

In order to be able to optimize port accessibility and dredging activities, Flanders Hydraulics Research initiated the development of a large physical model as an additional research tool to simulate the tidal variations in order to investigate in detail the currents near the port entrance and the water exchange through it. This paper focusses on the calibration of the physical model of the port of Zeebrugge.

Figure 1. Port of Zeebrugge (Maatschappij der Brugse Zeevaartinrichtingen, 2012).

## 2. Model set up

Figures 2 and 3 show the physical model. The dimensions of the physical model are approximately 55 m by 35 m (2000 m²) and represents approximately 15 km of the Belgian coastline around Zeebrugge. The horizontal scale is 1:300 and the vertical scale 1:100.


Figure 2. Overview of the large physical model. The coastline measures 55 m and the west boundary 35 m. The strong flood flows go from West to East across the access channel.

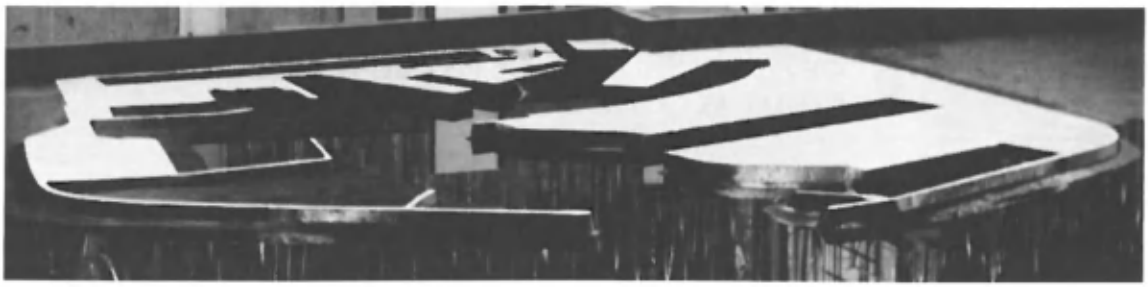

Figure 3. Detail of the port of Zeebrugge in the large physical model. The port measures 13 m by 13 m. The port entrance is 2.5 m wide.

The boundaries (Figure 4) are chosen based on simulations with a numerical Delft3D model for the Belgian coastal zone. The boundaries are located outside the zone of influence of future scenarios of the port layout. The orientation of the east side and west side is perpendicular to the current; the north side (seaward boundary) is as parallel as possible to the streamlines (Figure 5).

Nevertheless, as the velocity vectors describe an ellipse throughout the tide, the seaward boundary is an open boundary to impose a discharge in order to create the onshore/offshore velocity component. The east side and west side boundaries are controlled by water levels and discharges. The total pump capacity installed at this physical model is 1.4 $m^3/s$.

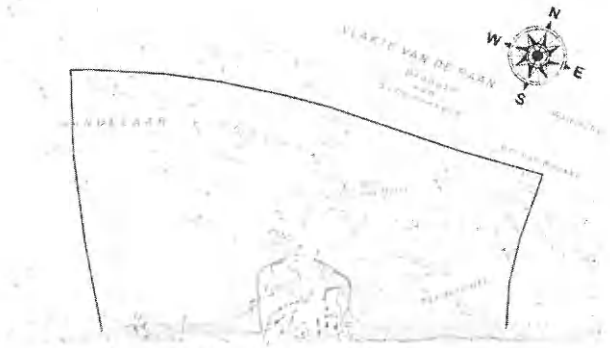


Figure 4. Physical model boundaries.

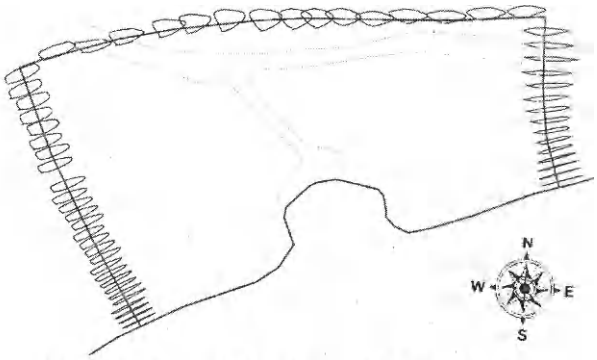


Figure 5. Current directions at the boundaries.

On-site measurements give information on the water level and tidal current in and close to the port. As limited information is available at the boundaries, the boundary conditions driving the physical model are determined from the output of the calibrated numerical Delft3D model for the Belgian coastal zone.

## 3. Results and conclusions

The model construction was finished at the end of 2011 (Willems et al, 2011). The calibration is done in 2012 by optimizing the boundary conditions and the roughness of the physical model. Water levels are measured by ultrasonic sensors and currents are measured by four quadrant electromagnetic velocity meters and float tracking.

Calibration is performed in 2 steps. Firstly the maximum flood current and maximum ebb current are imposed on the model. These stationary runs give insight in the relation between driving parameters (discharges, levels and roughness) and measured parameters (velocities and water levels). Secondly a whole tidal cycle is calibrated. Results of the calibration process will be presented at the conference.

This calibrated physical model, together with numerical models and a fast-time and real-time ship simulator, will be able to evaluate the accessibility and siltation of future port extensions.

## References

Maatschappij der Brugse Zeevaartinrichtingen 2012, *Overview | Port of Zeebrugge* [Homepage of http://www.portofzeebrugge.be.], [Online]. Available: http://www.portofzeebrugge.be/nl/image/tid/21 [11/05/2012].

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