Abstract 695:
Integrated Coastal and Maritime Plan for Oostende - Design of soft and hard coastal protection measures during the EIA procedures

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INTEGRATED MARITIME AND COASTAL PLAN

The town of Oostende is the service centre of the Belgian coast. It is an attractive sea resort with a rather small harbour at present, although Oostende has been one of the important ports on the Southern North Sea for many centuries.
The old town centre with its seawards position compared to the rest of the coastline (see fig 1.) and low laying city centre at about the mean high water level, is protected against flooding by a seawall which was built some 130 years ago. Due to the seawall the erosion process of the beach has accelerated and the seawall does not meet present safety standards against breaching and overtopping, which makes it a critical point in the coastal protection along the Belgian coast.

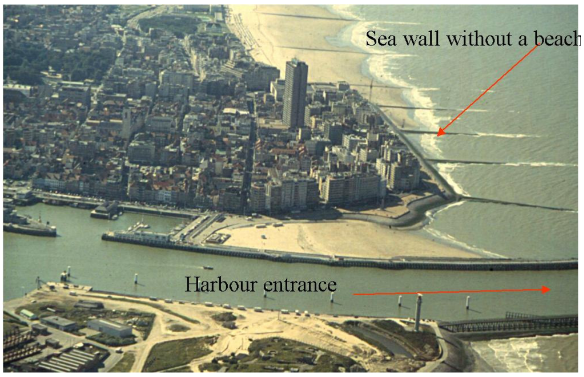

Fig. 1: Overview of the harbour entrance and the sea defence of the city of Oostende before 2004

The low seawall and its decades of influence on the beach erosion process, resulting in the absence of an important beach, cause high flood risks. During the storm of 1953 8 persons were killed in Oostende due to the flooding of the city. The material damage was huge as well.

In 2003 a panel of experts concluded that the flood risk of the city of Oostende starts from storms with a return period of 25 years and that the minimal allowed protection level should be a 1000 year storm with a maximum allowed overtopping discharge of 1 l/s/m [1].

Moreover important infrastructure works were executed in the inner harbour in the last decade, in order to make the harbour accessible to cruise ships, jumbo ferries and cargo ships with lengths up to 200 m. However to receive these ships, important modification works of the harbour access are also necessary.


Fig. 2: Overtopping event during a storm with small return period before 2004

Detailed coastal and harbour engineering studies have been executed, in which coastal protection and the nautical problems have been approached in an integrated way.

The integrated coastal protection and harbour project finally comprises the construction of two new breakwaters, a beach nourishment scheme and the construction of a new section of the sea wall.


Fig. 3: Construction concept of the two new breakwaters

DESIGN OF A NEW BEACH

In the 2003 situation the calculated overtopping discharge during a storm with return period of 1000 year was 100 to 200l/s/m. In anticipation of the execution of a sustainable project an emergency beach nourishment was necessary to increase the safety level to a more acceptable level (protection against a 100 year storm) was executed in 2004.

The new beach which will protect the city from flooding by a storm with a return period of 1000 year, must be high and broad enough and sufficiently stable, in order to temper the storm waves and prevent flooding of Oostende city centre.

The most important stabilising element for this beach is a dam construction that is perpendicular to the coastline at the north east side of the new beach This dam (breakwater) reduces longshore transport of sand that is mainly directed from south west to north east. This has a stabilising effect on the new beach and avoids sedimentation in the access chanel.

Two types of mathematical morphological models have been used for the design of the new beach.
The first type simulates the behaviour in cross profile during a 1000 year storm: the Dutch beach erosion DUROSTA software. The second type simulates the beach morphology up to 10 years after construction: the one-line model LITPACK and the multi-line model Pontos [2],[3].

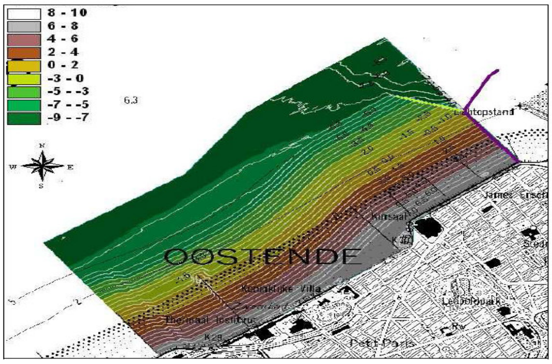

Fig. 4: design of the new beach

DESIGN OF THE NEW SEAWALL

In future a small stretch of the existing sea wall will be located between the new harbour breakwaters. This area is directly subject to waves penetrating via the harbour entrance (see fig. 3). There is no room for a new beach with a protection level for a 1000 year storm, therefore it was necessary to look for an alternative means of coastal protection which not only had to comply with technical requirements, but which could also be incorporated appropriately in the historical urban environment of this tourist beach resort. The solution is a stilling wave basin (SWB) with a smooth dike structure, as presented on ICCE 2006 [4].

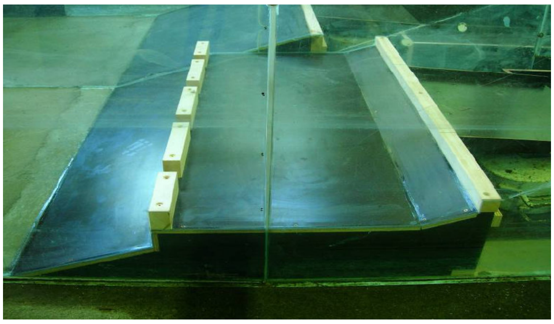

Fig. 5: Design of the Stilling Wave Basin (SWB) in the wave flume

During the design process several studies have been performed to determine the overtopping discharge behind the dike [5]. The incoming wave height at the toe of the dike was a result of SWAN, SIMWAVE and MILDwave numerical models (that has been verified for shoaling and breaking with GODA's method) [6], in an iterative process with the beach erosion DUROSTA-modelling during the storm event. These resulting wave heights and the SWL for the 1000 year storm have been used in wave flume tests at Ghent University and Flanders Hydraulics Research to predict the overtopping rate behind the SWB and the dike structure.

INTEGRATED DESIGN OF THE NEW SEAWALL AND THE WESTERN BREAKWATER

The full paper describes the design process of the coastal protection plan for Oostende city as a combination of soft and hard measures. It will present the study of several alternatives for the new beach and SWB construction [7].

These coastal protection measures, as well as the design of the western breakwater, had to be integrated in the historical city context during the Environmental Impact Assessment Studies (EIA-process) [8]. The study of different alternatives and variants results in a mitigated practical solution that will be executed the next years (see fig. 6).

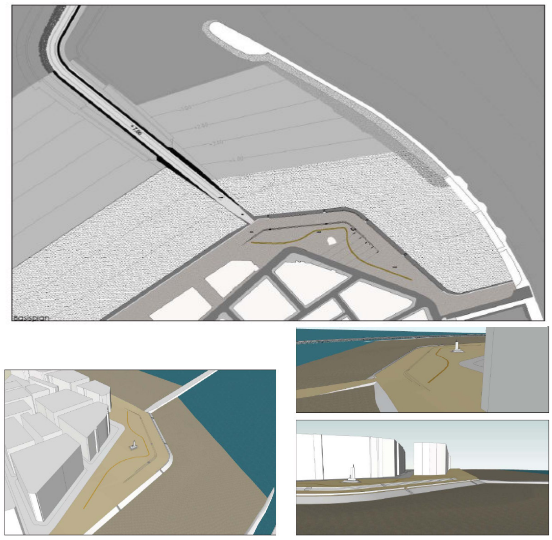

Fig. 6: Integrated and mitigated practical solution

REFERENCES

[1] J. De Rouck, J. Berlamont, M. Stive, 2003, *Zeedijk Oostende tussen Casino en Klein Strand - Advies panel Waterbouwkundige experten;,*
[2] K. Trouw, C. Martens (IMDC-Technum-Alkyon), 2004, *Structureel herstel van Oostende-Centrum en de verbetering van de haventoegang van Oostende - Morfologie;*
[3] A. Bolle, K. Trouw (IMDC), 2008, *Haventoegang Oostende - Westelijk Strand;*
[4] J. Geeraerts, J. De Rouck, S. Gysens, C. Beels, P. DeWolf, 2006, *Reduction of wave overtopping at seadikes: Stilling Wave Basin;*
[5] K. Van Doorslaer, J. De Rouck, S; Gysens, 2009, *Reduction of Wave Overtopping: From Research to Practise;*
[6] P. Troch, D.Vanneste, V.Stratigaki, (Ugent), 2009, *Design of Oostende Harbour: Numerical Simulation of Wave Propagation - Inside Area Breakwaters*;
[7] A. Bolle, K. Trouw, J. De Rouck, M. Willems (IMDC-UGent-Flanders Hydraulics), 2009, *Haventoegang Oostende - Ontwerp Zeeheldenplein, Havendammen en Groeistrand;*
[8] P. Arts, J. Parys, R. Colpaert, T. Opdebeek (Soresma), 2009, *Kustverdedigingen maritieme toegankelijkheid van oostende - Project-MER - Definitief rapport*