



DHI CASE STORY

THE HANSTHOLM HARBOUR EXPANSION

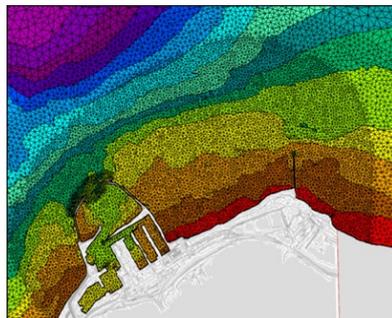
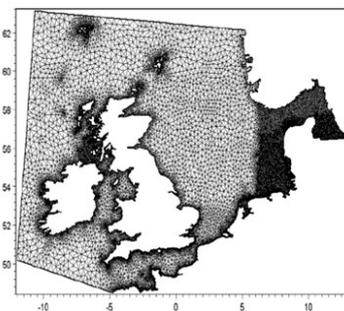
Effective dredging solutions for a larger harbour

To improve navigation and to accommodate larger ships, a major harbour expansion is being planned for the Danish Port of Hanstholm. Since it is a bypass harbour, the Port allows a large part of the sand moving along the coast to pass, decreasing the need for dredging. The future harbour's expansion plans however, may cause sedimentation to increase. We analysed the sedimentation conditions and suggested a dredging approach which could meet the growing navigation needs. We also assessed the environmental impact of the planned development. Thus, our dredging solutions made it possible for our client to effectively proceed with the expansion plans.

THE PORT OF HANSTHOLM – A CANDIDATE FOR GROWTH

The Port of Hanstholm, located on the Danish West Coast, is the perfect example of a bypass harbour. It allows a major portion of the sand travelling along the coast to pass without dredging. A major expansion of the harbour is being planned to:

- Improve the navigation conditions
- Increase the navigation depth
- Permit larger ships to call at the port



Regional and local grids from the MIKE 21 FM model

Our history with Hanstholm goes back several decades. When Hanstholm Harbour was first being built on the northwest coast of Denmark, its construction was seen as infeasible. But two of our founders – Professor Helge Lundgren and Director Torben Sørensen – re-examined the technical aspects of the project. Based on their findings, a new report concluded the project was sound, allowing for the construction of Hanstholm Harbour.

SUMMARY

CLIENT

Grontmij A/S and the Port of Hanstholm

CHALLENGE

- Uncertainties regarding the future dredging requirements for a major harbour expansion
- Need to determine the future impact of the expansion on surrounding coastlines

SOLUTION

- Analysis of future conditions for sand bypass and sedimentation at the new harbour
- Development of possible dredging strategies for planned larger scale dredging operations
- Determination of probable future erosional impact on the coastlines
- Presentation of possible remedial actions in the form of artificial sediment bypass

VALUE

- Provided input required for the preparation of the Environmental Impact Assessment (EIA)
- Empowered the client to proceed with planning and design of the harbor expansion

LOCATION / COUNTRY

Hanstholm, Denmark

Nearly 50 years later, we were asked to assist with the port expansion. Grontmij A/S requested that analyse and find a solution to the problems posed by sedimentation. After conducting a thorough analysis, we found that the bypass could not be upheld with the improved navigation depth in the planned harbour expansion. Therefore, we analysed the sedimentation conditions and suggested a dredging approach which could meet the growing navigation needs. In parallel, we also studied the possible environmental impacts of the planned development.

COMBINING MODELLING AND ADVANCED FIELD MEASUREMENTS FOR AN EXTENSIVE STUDY

We used MIKE 21 (our 2D modelling software) to model the current conditions at the harbour. We studied:

- wave transformation
- currents
- sediment transport
- morphological evolution

MIKE 21 allowed us to provide an adequate coverage of the overall port surroundings. It also permitted us to maintain the required level of detail at key locations, while achieving reasonable model simulation times.

To provide the basis for the model calibration, we measured waves and current at a position in front of the harbour. For this purpose, we used the 'Triaxis' wave buoy, which includes an Acoustic Doppler Current Profiler (ADCP). In a one-day campaign, we further measured the detailed distribution of the current that passes the harbour in a number of transects (horizontal profiles) using a vessel-mounted ADCP instrument.

We used these results to calibrate our models. This allowed us to analyse present and future conditions for sedimentation, sea bed configuration, bypass and coastal erosion. Our models, supported by advanced field measurements, are capable of predicting the consequences of a harbour expansion on sedimentation.

Over the course of the project, we:

- developed a new technique for determining the equilibrium configuration of sand deposits along the breakwater around the future harbour
- further developed our software describing coastline evolution. This included the representation of a hard non-erodible coastline in the model.

PAVING THE WAY FOR A LARGER HARBOUR WITH AN ARTIFICIAL BYPASS

If the sediment bypass at the harbour is changed it will have an impact on the surrounding coastlines. A reduction in bypass of sand could lead to increased coastal erosion east of the harbour. We suggested that this could be eliminated by

depositing the sand dredged from the harbour close to the shoreline, thus creating an artificial bypass.

The sediment transport study showed that the favourable bypass conditions could not be upheld with the large improvement in navigation depth. The sediment coming from the south would be deposited along the new main breakwater and (if unchecked), the deposition would eventually reach the new harbour entrance causing a reduction in the depth.

Thus, we came to the conclusion that a bypass solution without significant maintenance dredging was not realistic. A dredging strategy had to be devised to enable uninterrupted operation of the harbour. We described how the sand would deposit along the breakwater and how we could develop a dredging strategy to accommodate planning of the dredging operations. We determined the evolution of the deposition and the equilibrium configuration. This allowed for a dredging strategy with a sediment reservoir, making it possible to plan for fewer and larger dredging operations.

THE ENVIRONMENTAL IMPACT ASSESMENT

We assessed the possible impact on the surrounding coastlines from the reduced bypass as a contribution to the Environmental Impact Assessment (EIA). The study involved the following:

- Analyses of historical charts
- Establishment of sediment budgets
- Numerical modelling of longshore sediment transport and coastline evolution by the LITPACK model system

The existing sediment budget for the surrounding coastline is established, explaining the historic retreat of several hundred meters occurring east of the harbour. On a long stretch of the coastline east of the harbour the tendency for coastal erosion is arrested by layers of resistant limestone.

As such, we further developed the LITPACK model system to take the hard erosion resistant coast into account. LITPACK models have been set up to describe the future conditions for littoral transport and coastline evolution for different rates of bypass. Increase in the future coastal erosion can thus be prevented by artificial bypass of the material to be dredged from the area of deposition along the new main breakwater and by placing it near the shoreline east of the harbour.

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