EXPANSION OF THE PORT OF HANSTHOLM

DESIGN OF PORT LAYOUT AND DEVELOPMENT OF SPUR BREAKWATER

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LOCATION
**PROJECT OVERVIEW**

- The Port of Hanstholm, located at the west coast of Denmark, is planning to expand the port within a financial frame approx. DKK 525 mill.

- Rambøll, Denmark, is client advisor for the project

- Services include:
  - Preparation of a business case
  - Handling of the authorities
  - Preparation of port expansion layout
  - Preparation of conceptual design
  - Advice on the tender process
  - Cost estimates / risk analysis
  - Numerical modelling of waves, current, and sedimentation (costs related to downtime and dredging)
  - Evaluation of navigation issues etc. (downtime related to navigation)
  - Check of detailed design from contractor
  - Client advice during project execution
PRE-QUALIFIED CONTRACTORS
CHALLENGING CONDITIONS AT THE PORT OF HANSTHOLM

• **Large depth-limited (breaking), non-linear, waves** ($H_m > 8 \text{ m}, T_p \approx 16 \text{ s}$)
  - Expensive structures (breakwaters)
  - Challenging to predict design wave loads due to breaking (non-linear) wave conditions
  - Challenging conditions during construction (down-time)

• **Strong currents and significant sediment bypass** (> 500,000 m³/year)
  - Problematic navigation conditions
  - Risk of downtime due to sedimentation of navigation channel
  - High maintenance costs due to sedimentation of port basins
SCOPE OF THE PROJECT

- **Budget**: Approx. DKK 500 Million
  - Improved navigation conditions
  - Larger hinterland area (100,000 m²)
  - Accommodation of larger vessels
  - Reduced wave disturbance/downtime in existing port and acceptable downtime along the new quay
  - Larger water depth in navigation channel and in the new basin
  - New quay (minimum 300 m)
  - Low maintenance costs due to dredging
  - Create more jobs in the port and in the surrounding area
  - New jobs in the port and in the surrounding area

Photo: Aarsleff
TIMELINE

1917-41
The first attempt of constructing a new port (under guidance of Fibiger). The attempt is finally cancelled in 1950.

1955
A new attempt of constructing a port is initiated (under guidance of Lundgren).

1967
The port is finalized.

2009-13
New plans for port expansion, which, however, are later put on hold.

2016
Plans for port expansion are being re-addressed, and call for client advisory is initiated.
HOW THE PROJECT BECOMES A SUCCESS

- Business Case
- Information meeting with the local community
- Handling of authorities (EIA etc.)
- Continuous update of management board
- Optimized navigational conditions
- Project meetings
- Handling of risks
- Realistic estimates on construction costs
- Reduced downtime due to seiche
- Matching of expectations
- Detailed analyses of future maintenance costs due to siltation
- Interviews with users and potential clients
- Meetings with council of municipality
- Market dialog

Photo: Aarsleff
THE FIRST SKETCHES OF PORT EXPANSION LAYOUTS

Photo: Aarsleff

NordPIANC2019 – Hirtshals/Hanstholm
THE CHOSEN EXPANSION PROJECT

Within the budget of DKK 525 mill.
Can accommodate larger vessels
Wave disturbance reduced in existing port basins (more details later)
Improved navigation conditions (more details later)
130,000 m² more hinterland
Water depth generally increased by two meters
500 m quay
Acceptable maintenance costs due to siltation (more details later)
POSSIBLE PHASE-TWO EXPANSION
SOME OF THE DETAILED TECHNICAL ANALYSES PERFORMED...:

- Optimization of navigational conditions
- Optimization of layout for minimum disturbance modelling
- Optimization of layout for siltation in navigational channel
- Physical model tests
- Detailed investigation of influence from expansion project on existing structures
- Development of detailed model for “Expected and excused delay due to wave conditions”
SIMULATION OF SHIP NAVIGATION (FORCE)

• Current-conditions in the ship navigation analyses was based on detailed hydrodynamic modelling (performed by Rambøll)
### DOWN TIME ANALYSIS – WAVE AGITATION

#### Existing port

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#### Layout A

#### Layout B

#### Layout C

Example: 285 – 315 deg

Photo: Aarsleff
CONCLUSIONS FROM WAVE AGITATION STUDY

- The chosen layout (Layout C) provides a significant reduction in wave disturbance in the existing port basins.
- Acceptable downtime is achieved at the new quays.
- Significantly reduced wave heights in the port entrance (i.e. improved navigational conditions).
- Acceptable conditions in relation to standing (long) waves in the new basin (based on evaluation of Eigenfrequency in the basin).
Most of the sediment transport occurs during short storm periods.

Waves larger than 3m contribute with roughly 90% of the sediment transport at a water depth of 8 m.

The southward transport is found to be only 1% of the net transport.
SEDIMENT TRANSPORT MODELLING

• Modelled:
  • Waves
  • Wave generated currents
  • Long-shore transport
SEDIMENT TRANSPORT MODELLING

- Different representative storm conditions considered
- Both north and south sediment transport is considered

![Graph showing wave height and current speed for storms 1, 2, and 3.](Photo: Aarsleff)
SILTATION IN NAVIGATIONAL CHANNEL

- Siltation after a typical (one-year winter storm) from NW

[Diagram showing existing port and layouts A, B, and C with bypass lines]
SILTATION IN NAVIGATIONAL CHANNEL

- Siltation after a typical (one-year winter storm) from NE
• The natural bypass in the future situation is reduced by approximately 50 % compared to the existing condition

• The analysis of bypass reduction is not very sensitive to the evaluated storm condition, which means that the choice of simulating only a few representative storms provide a relatively robust conclusion

• The dredging volume, which needs to be artificially bypassed, is estimated to increase from approximately 100.000 m3/year to approximately 300.000 m3/year
DEVELOPMENT OF “SPUR”-BREAKWATER

- Different concepts were investigated to reduce the siltation in the navigation channel (sediment reservoir and a “spur” breakwater). The spur breakwater proved to be working very well when positioned in the “acceleration zone” near the breakwater head.
The spur-breakwater proved to be stable with a crest level in −5, and showed to be reasonably effective with a length of 60 m.
THANK YOU FOR THE ATTENTION

QUESTIONS?