Ferry Port at Landeyjahöfn

Research and Development of the Ferry Port and navigational criteria for the Ferry at Landeyjahöfn

NordPIANC Meeting

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Ferry Port project between Vestmannaeyjar and the main land

- Cut the sailing distance for the ferry from 3 hours to 0.5 hours by navigating safely through the breaking zone with intensive wave breaking and heavy littoral drift.

- Find a location on the coast with overall dynamic stable offshore sandbar with minimum acceptable depth for navigation and with minimum net littoral drift along the shore.

- Design a layout for the Ferry Port where minimum sedimentation into the Port and minimum equilibrium depth in front of the entrance is achieved.

- Find a rock quarry for building the Icelandic Berm Breakwater for the Port.

- Fulfilled all international standards regarding design and safety.
Bakkafjara Ferry Project
South Coast of Iceland
2000 to 2010
Inshore wave recordings 2003 -

Offshore wave recordings 1987 -

Offshore Wave Data Era 40 1958 -

COLECTING FIELD DATA

Grain size

River discharge 1962-2002

Regulasy bathymetries

IMA's tidal elevation and current

18 Oct. 2002

River discharge and sediment loads

COLECTING FIELD DATA
Wave analysis and sediment transport based on DHI’s Mike21 SW, Mike 21 FM, HD and ST and LITPACK

West Southwest 52 %

South 23 %

East Southeast 26 %

ECMWF data
Bathymetries

Heavy wave breaking on a sandy bar some 1000 m offshore the shore with 2 m tidal range

Deep through at 10 to 12 m and depression in bar at 6 m in average

Bar to the west and spit from the east
The exposed sandy South Coast of Iceland is one of the most dangerous coast for sea fares.
Criteria for safe navigation
Navigational tests over the sandbar for the ferry

Navigational criteria were established for the ferry over the sandbar into the ferry port by:

- 1) sailing by the remote controlled model ferry,
- 2) counting the number of breaking waves,
- 3) wave measurements at 18 m, 15 m, 10 m and 6 m in front, at the top and at 10 m depth landward the bar and in front of the ferry entrance.
- 4) Evaluation of the total depth based on wave height, tidal elevation and the draft of the ferry.
Sailing with model ferry by a captain with 16 years experiences from the side
Number of breaking waves

The maximum possible significant breaking wave is according to Kamphuise (1991)

\[ \frac{H_{sb}}{h} = 0.56 e^{3.5 \text{ m}} \]

where \( m \) is the bottom slope of 1/50
Significant wave height (m) variation along the navigation line. Wave direction from south. The results are based on model tests and numerical simulations. Harbour entrance is located at distance 180 m.
Significant wave height for the Ferry vary linearly the water level, WL, disregarding wave direction.

$$H_{s_{\text{weighted}}} = 3.4 + 0.2 \times WL$$
Safe Navigational Criteria for the Ferry over the bar and into the Ferry Port at Landeyjahöfn

Remote controlled ferry, draft 4.0 m

\[ H_s = 3.4 + 0.2 \times WL \] down time 3.9%

Proposed Ferry, draft 3.3 m

\[ H_s = 3.6 + 0.2 \times WL \] down time 2.8%

Existing Ferry, draft 4.3 m

\[ H_s = 3.2 + 0.2 \times WL \] down time 5.0 %

for 2003 - 2006

Wave buoy - measurements

Bakkafjörudufl 63°30.62’ N 20°08.60’ W rv. 169°, 1.6 nm. from Bakkafjöruviti

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Sediment transport at the Port

The main natural forces

- Wave energy
- Vestmannaeyjar
- Sandy coast
- Tidal currents
- River discharge from Markarfljót River

The aim of the study was to investigate:

- Minimum net transport at the shore
- The overall stability of the bar and the depression in the bar
- Sedimentation rates into the Port
- Equilibrium depth in front of the entrance
Net: 0.3 mill m$^3$/yr Eastgoing
Gross: 2.5 mill m$^3$/yr

Net: 0.4 mill m$^3$/yr Eastgoing
Gross: 1.2 mill m$^3$/yr

Net: 0.1 mill m$^3$/yr
Dredging to -7m over 150 m

Minimum wave breaking cause increased rip current due to wave set up which maintains natural deepening around the dredged area.
Only long duration of low SW waves can cause problems with minimum depth at the bar and in front of the entrance.
Low SW waves in September

After 5 months of 2.7 m SW wave
Ferry Port project between Vestmannaeyjar and the main land

- Technically and economically feasible to build a Ferry Port on the South Coast by navigating safely through the breaking zone in front of the Port.

- Only one location at the coast is with a dynamic stable bar with minimum acceptable depth of 5 - 6 m for navigation and with minimum net littoral drift along the shore of 0.1 mill m³ / yr.

- Design the layout of the Ferry Port with estimated 30,000 m³ / yr sedimentation into the Port with 90 m wide entrance and minimum equilibrium depth in front of the entrance of 5.5 m is achieved.

- High quality rock quarry is available for building Icelandic Berm Breakwater at the Port

- The whole project fulfilled all international standards regarding design and safety
Welcome to Landeyjahöfn tomorrow
Thank you