Landeyjahöfn
Ferry harbour on the South Coast of Iceland

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

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Presented by

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The aim of the Ferry Port project between Vestmannaeyjar and the mainland:

• 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.
LANDEYJAHÖFN
The new Ferry Harbour on the South Coast of Iceland

FIMMVÖRÐUHÁLS 20 March – 12 April 2010

EYJAFJALLAJÖKULL 14 APRIL - ???
Vestmannaeyjar –– Heimaey
23. 01.73 – 3.07.1973

Surtsey
14 Nov. 1963 – 5 June 1967
Inshore wave recordings
2003 -

Offshore wave recordings
1987 -

Offshore Wave Data

ECMWF ERA 40 1958 -

Grain size

River discharge 1962-2002

IMA’s tidal elevation and current

COLLECTING FIELD DATA

Regular bathymetries

Wave rose

Max tidal range 3 m.
Wave analysis and sediment transport based on DHI’s Mike21 SW and Mike 21 FM, HD and ST and LITPACK

West-Southwest 52%

South 23%

East-Southeast 25%

ECMWF data
Heavy wave breaking on a sandy bar some 900 m off the shore with 2 m tidal range

Deep trough 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 dangerous for seafarers. Hundreds of vessels have perished here and hundreds of seafarers have lost their lives.
Experienced master sailed the remote-controlled model ferry.
Number of breaking waves on the bar

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

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

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.

Ferry, with draft 4.3 m. Wave height criteria:

\[ Hs = 3.2 + 0.2 \times \text{waterlevel} \]
Jökulhlaup 14 April 2010

River discharge of sediments 200,000 m$^3$ after the flood

Jökulhlaup (Glacial flood):
Max. discharge 2700 m$^3$/s
Total discharge 75 $10^6$ m$^3$

Annual discharge of sediments 100,000 m$^3$/yr

\[ Q_{100\text{yr}} = 1250 \text{ m}^3/\text{s} \]
Annual discharge of sediments from the river 0.1

Net nearshore sediment budget, mill m³/yr

Bakkafjara

0.1

0.3

0.4
Average sediment transport, selected periods
Sediment transport along the inner part of the profile toward East for waves from W-SSE and toward West for SSE – E

Nov-Dec. 1985

-210,000 m³/month
34,000 m³/month

Feb. 1989

310,000 m³/month
190,000 m³/month
Morphological changes near the ferry harbour
Waverose
1 Oct – 30 Jan 2010

Comparison between nature and simulations

Bathymetry 31 Jan 2010
Sedimentation into the harbour 160,000 m³
Ferry Port project between Vestmannaeyjar and the mainland in conclusion:

- 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 for navigation and with minimum net littoral drift along the shore.

- Design the layout of the Ferry Port with minimum sedimentation into the Port and minimum equilibrium depth in front of the entrance is achieved.
Breakwater section

- Significant wave height $H_s = 6.1m$
- Necessary stone size for Ice BB up to 30 tons
- Availability of armour stones at Quarry site, 25 km distance.
- Quarry yield predicted 27-37% > 1t and 8-12% > 10t.
Quarry run in March 2009

Landeyjahöfn September 2009
Landeyjahöfn October 2009
Open for service on 21. July 2010?

Thank you