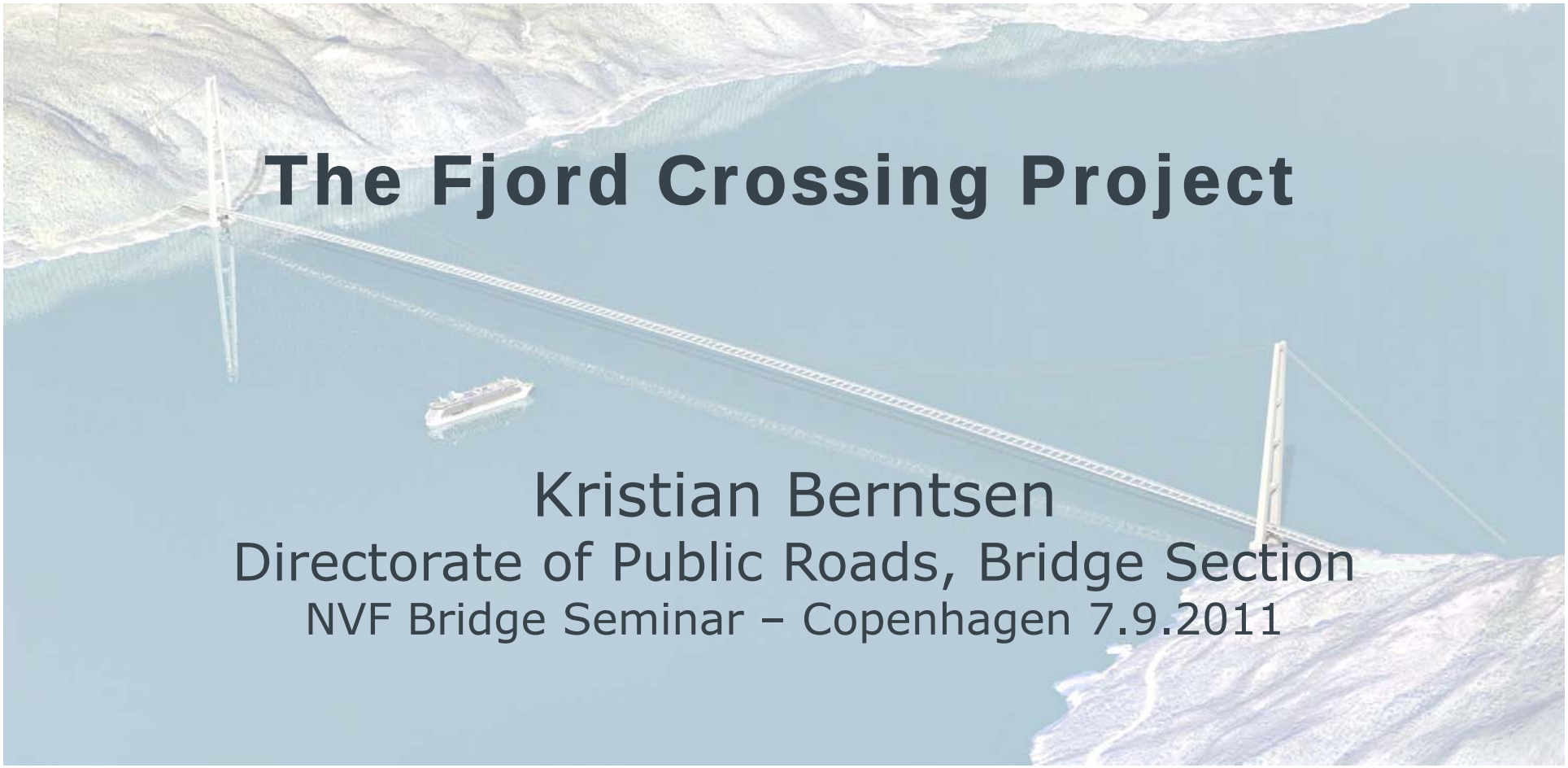


The Fjord Crossing Project

Kristian Berntsen
Directorate of Public Roads, Bridge Section
NVF Bridge Seminar – Copenhagen 7.9.2011

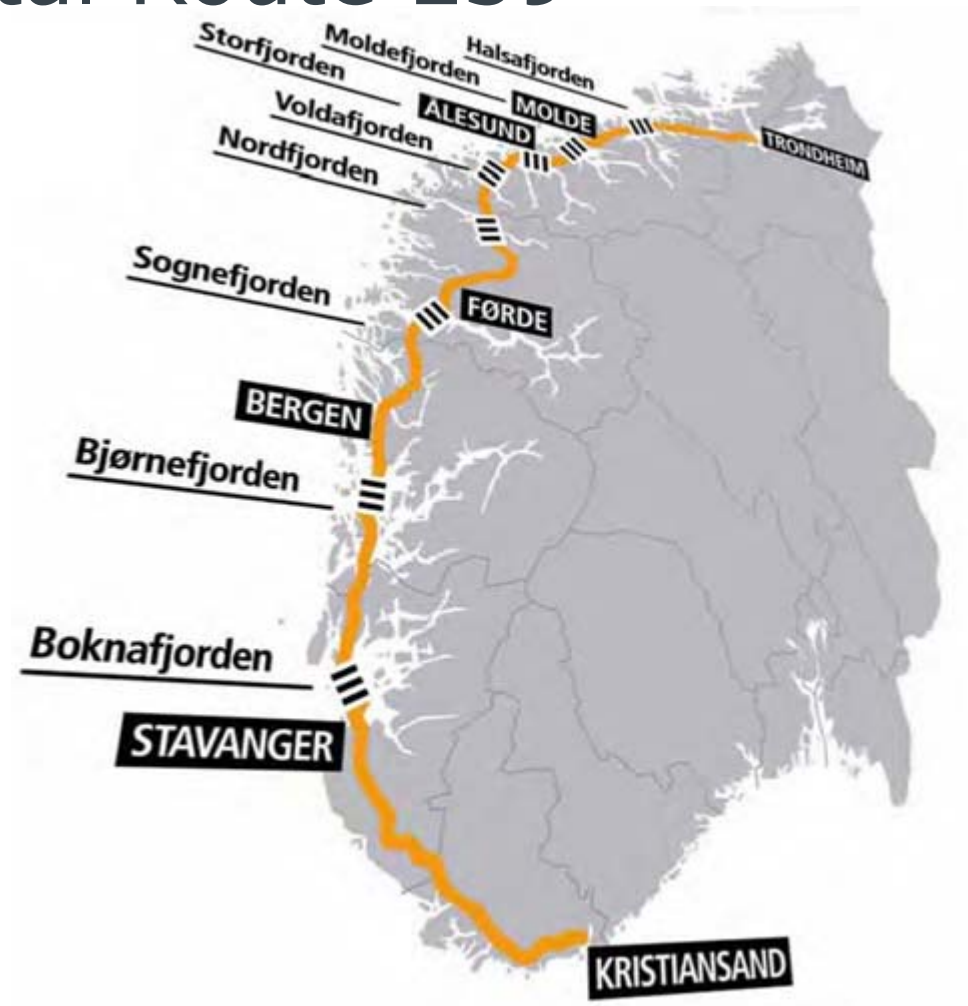
Overview of the presentation

- The Coastal Route E39
- Organisation of the Fjord Crossing Project
- What has been done
- What problems do we need to solve
- How do we solve these problems

The Coastal Route E39

- Runs through six counties
- 1,75 mill. inhabitants
- 50% of total exports
  (not counting oil and shipping)
- 8 ferries remain

- Trondheim-Kristiansand
  21 hours today
  13 hours without ferries



The Coastal Route E39
The remaining crossings

- Halsafjorden
  - 2000 m crossing, 200 m deep
- Moldefjorden
  - 1600 m bridge in combination with 13 km sub-sea rock tunnel
- Storfjorden
  - 3100-3400 m crossing, 450 m deep
- Voldafjorden
  - 2500 m crossing, 600 m deep, possible to bypass
- Nordfjorden
  - 1500-1800 m crossing, 150 m deep loose soil

The Coastal Route E39
The remaining crossings

- **Sognefjorden**
  - 3700 m crossing, ca. 1300 m deep
- Bjørnefjorden
  - Up to 5 km crossing, 500 m deep, possible to bypass with 1,3 km crossing
- Boknafjorden
  - 25 km sub-sea rock tunnel, 360 m deep

Organisation of the Fjord Crossing Project

- The Fjord Crossing Project is led by Olav Ellevset directly under the Director of Public Roads.
- The Fjord Crossing Project is divided into two sub-projects:
  - Socioeconomics (Region midt)
  - **Technology** (Region vest)

Our task is to find out
what is technologically possible
for the fjord crossings

What has been done

«We have for a long time considered that the limit of the free span of a suspension bridge with 2 lanes of traffic is between 600 and 700 m. In 1970 the Directorate of Public Roads, in cooperation with NTH and Sintef, started a research program on the stability of long slender suspension bridges when exposed to wind considered as a stochastic variable load.

In 1980 researchers Roald Fredriksen and Erik Hjorth-Hansen presented the results of theoretical and experimental research and concluded that in most parts of the country it is possible to construct slender bridges with sufficient safety to – for spans all the way up to 1200 m.»

What has been done

Askøybrua
850 m span
Opened in 1992

Hardangerbrua, 1310 m span, due to open in 2013

Nordhordalandsbrua, 1243 m floating span, opened in 1994

Bergsøysundbrua 931 m floating span, opened in 1992

What has been done

- Akashi-Kaikyō
  1991 m free span
  Messina Bridge
  3 300 m free span
- The Norwegian floating bridges are still state of the art
- No submerged floating tunnels have been built, but experience from submerged tunnels can be used

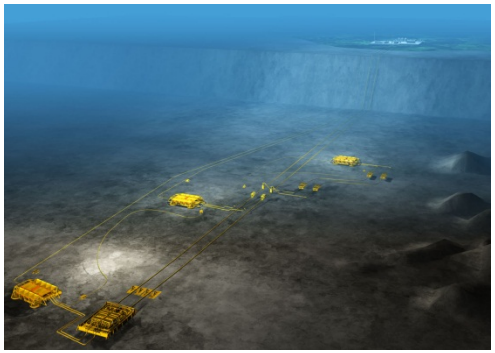
What has been done
Technological advances off-shore

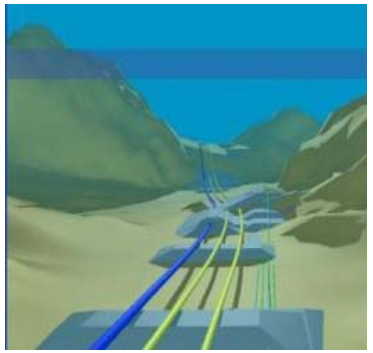
The Ekofisk tank:
70 m deep (1973)

The Troll platform:
303 m deep (1995)

Floating platforms (TLP) anchored at more than 1500 m deep

Sub-sea wellheads, subsea pipelines





Ill: Reinertsen

What has been done

- Feasibility study of the crossing of the Sognefjord started with two idea seminars:
  - Floating bridges and submerged floating tunnels
    in December 2009
  - Suspension bridges in February 2010
- The idea phase of the feasibility study is now completed
- Cost estimates on several crossings along E39 have been done
- The next step is to attempt to document that the solutions actually will work

What problems do we need to solve Suspension bridge

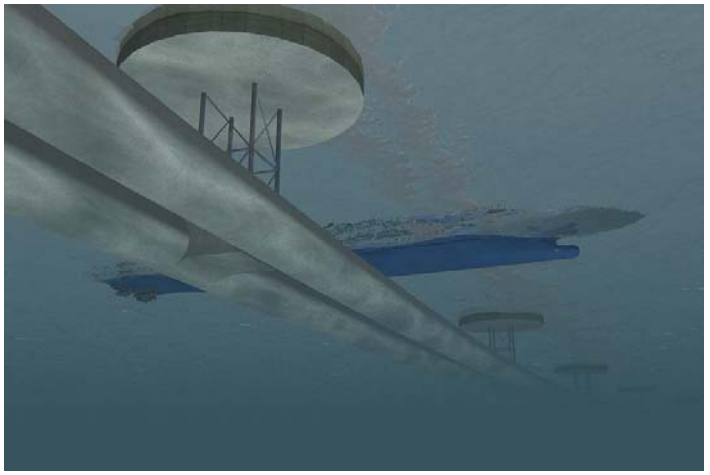
- The free span of a traditional suspension bridge with two lanes of traffic is now thought to have a limit around 1500 m. We need to come up with a new suspension bridge that fulfill our needs, longer and slender.
- Better understanding of the forces from wind

What problems do we need to solve Floating bridge

- Find the limit of how long a end-anchored floating bridge can be.
- Anchored floating bridge.
- Stability when exposed to slow moving loads.
- Problems with passing of ships.

What problems do we need to solve Submerged floating tunnels

- Find the limit of how long a end-anchored submerged floating tunnel can be.
- Safety issues, risk evaluation.
- Stability when exposed to slow moving loads.
- Construction methods and costs.
- Anchored submerged floating tunnels.



How do we solve these problems

- Suspension bridge
  - Directorate of Public Roads in cooperation with research institutes such as NTNU.
  - Full scale measurements on the Hardanger bridge
- Floating bridges and submerged floating tunnels
  - Private companies in cooperation with research institutes such as NTNU.
  - Challenges on how to make a good tender.

Thank you for your attention

Film: Hardangerbrua

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