

FERGEFRI E39
4-FELT KRISTIANSAND - TRONDHEIM

FLYTEBRU-PROSJEKTER

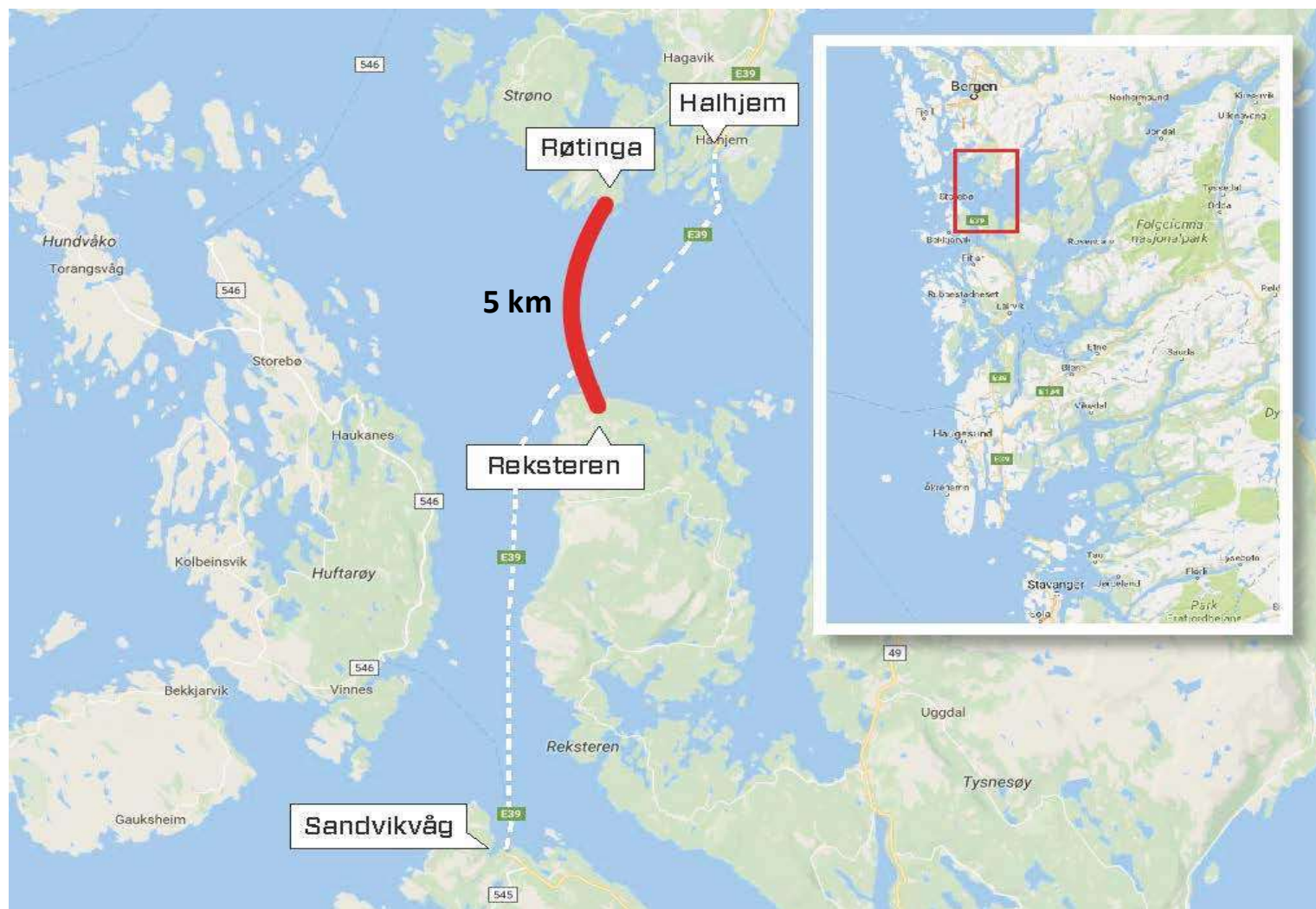


A map of Norway and Sweden showing a ferry route. The route starts in Trondheim, Norway, and goes south along the coast, passing through Molde, Ålesund, Bergen, Haugesund, and Stavanger, before ending in Kristiansand. A callout box indicates a travel time of 23 h 34 min and a distance of 1,293 km. Major cities like Oslo, Stockholm, and Göteborg are also labeled. The map shows the Gulf of Bothnia between Norway and Sweden.

YTRE LEIA E39

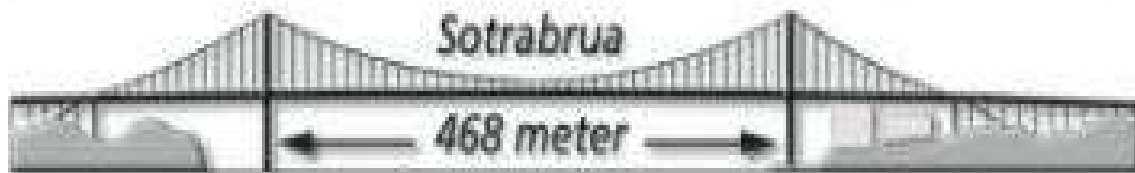
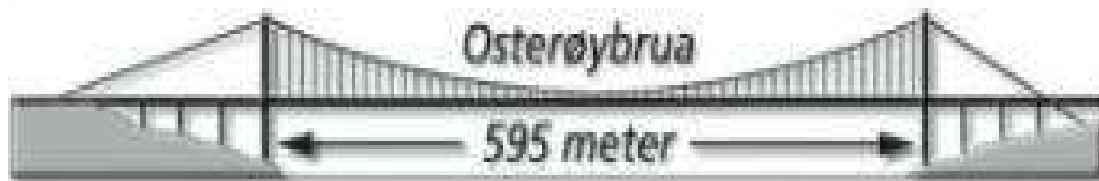
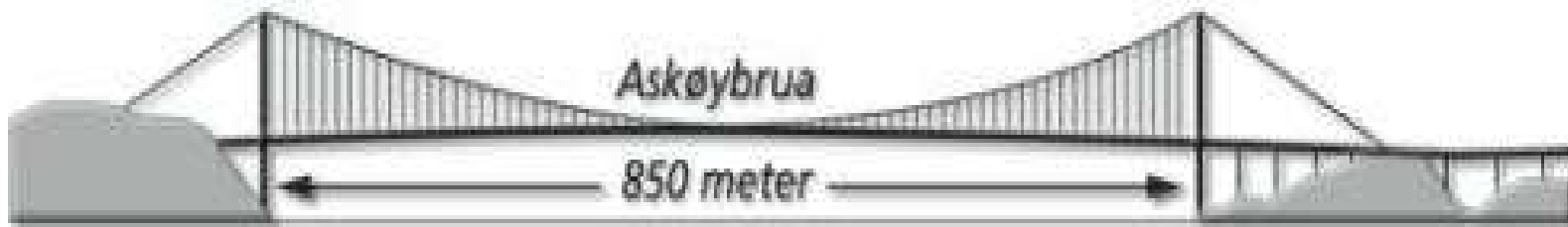






HARDANGERBRUA – 1310m







Hengebruer – utvikling

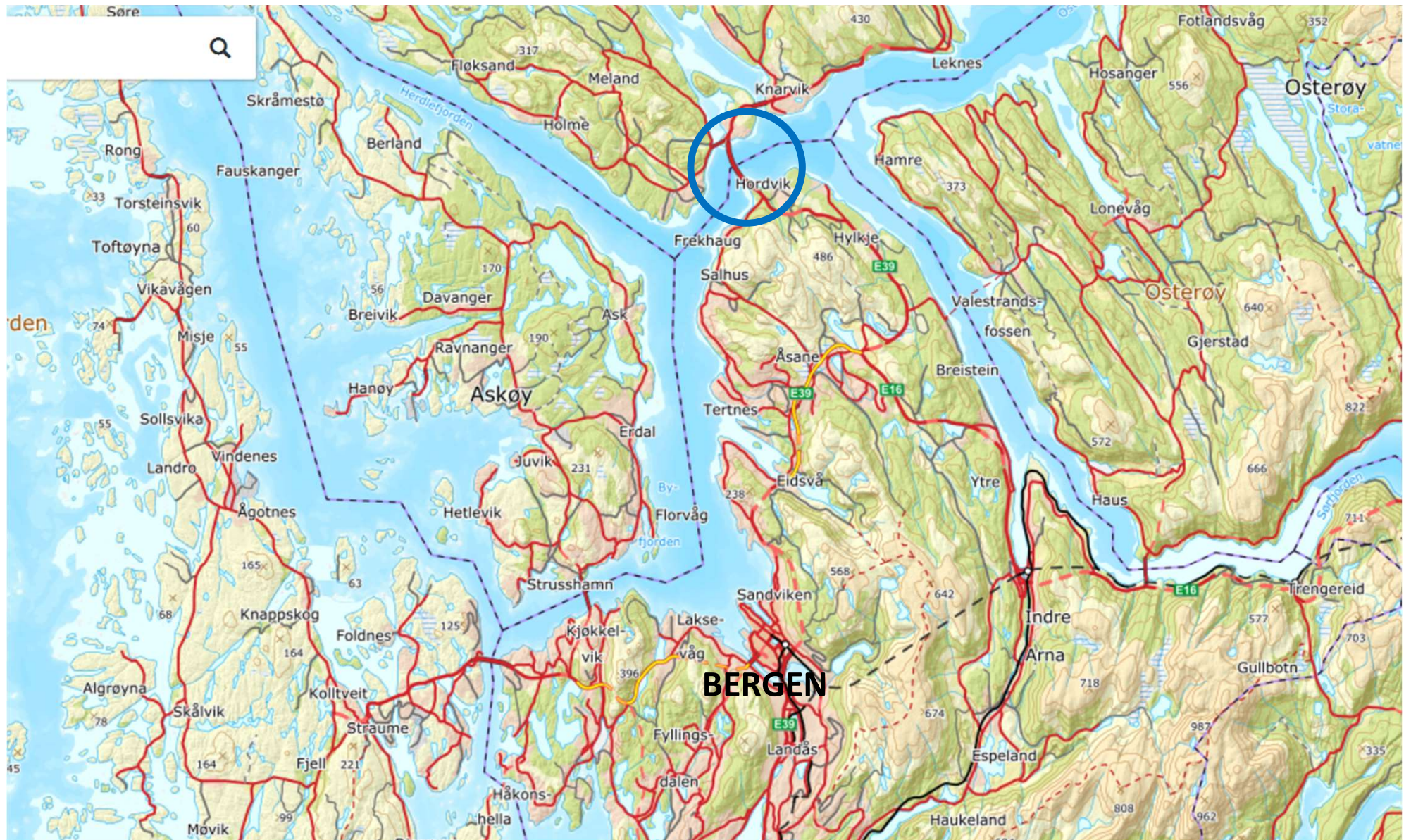
- Messinabrua – planlagt, ikke bygd
- Stålkasser – 2 stk. brukasser
- Spenn 3300m

Statens vegvesen



NORDHORDLANDSBRUA 1230m flytebru





BERGSØYSUNDET FLYTEBRU 1992 930m





E39 Bergsøysundbrua : 1990 – 1992

Statens vegvesen

Pongtonger:
Norwegian Contractors,
Hinnavågen



Stål overbygning :
Aker Verdal



FLYTEBRU MED MIDTSPENN



B: Flytebru m/ skipssluse



Sellingsled:

- Bredde : 50 – 150 m
- Dybde : 6 - 20 m
- Høyde : Fri



PontelMar

patent pending

Naval Architects and Engineers



PONGTONG-BRU



Broen holdes oppe ved hjelp av pongtongene festet til understellet, som flyter i vannet.

LAKE WASHINGTON FLOATING BRIDGE – 2370m









BJØRNAFJORDEN NASJONAL TRANSPORTPLAN – 30 MRD



BILLIGERE



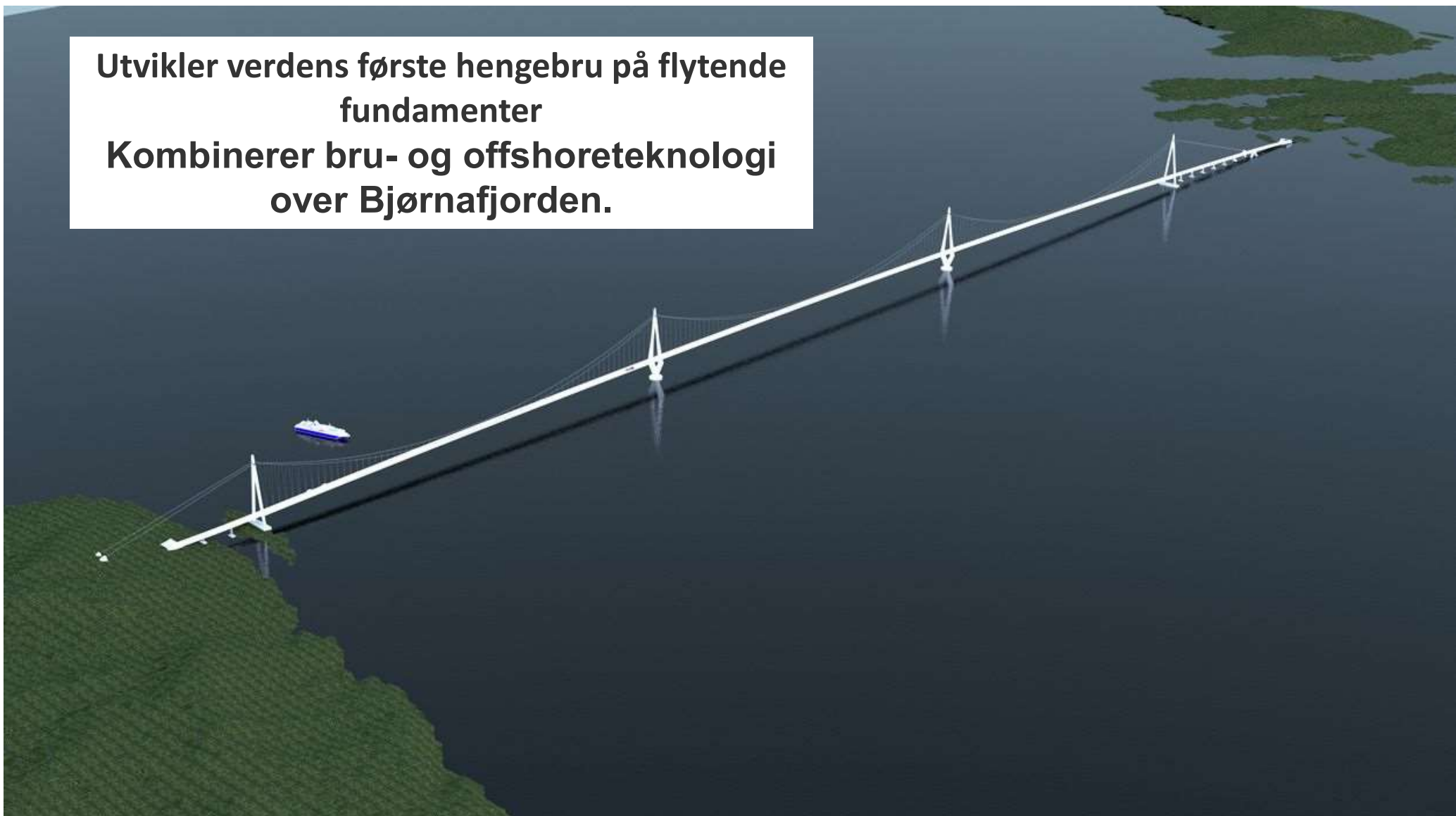
NORDHORDLANDSBRUA 1230m flytebru



RETT BRU – FUGE 300mm



**Utvikler verdens første hengebru på flytende
fundamenter
Kombinerer bru- og offshoret Teknologi
over Bjørnafjorden.**



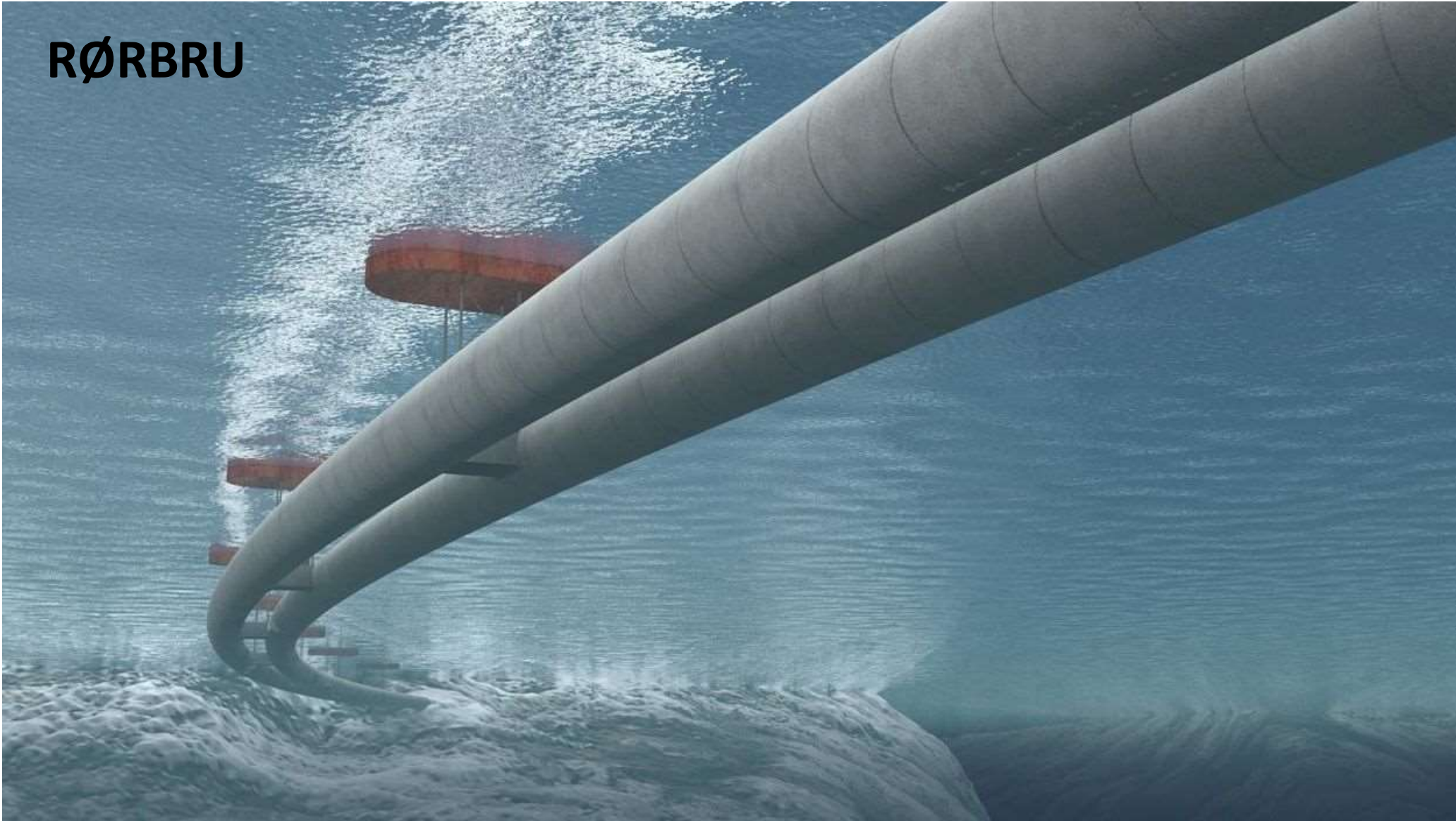




TO BRUBJELKER – FOR MYK



RØRBRU

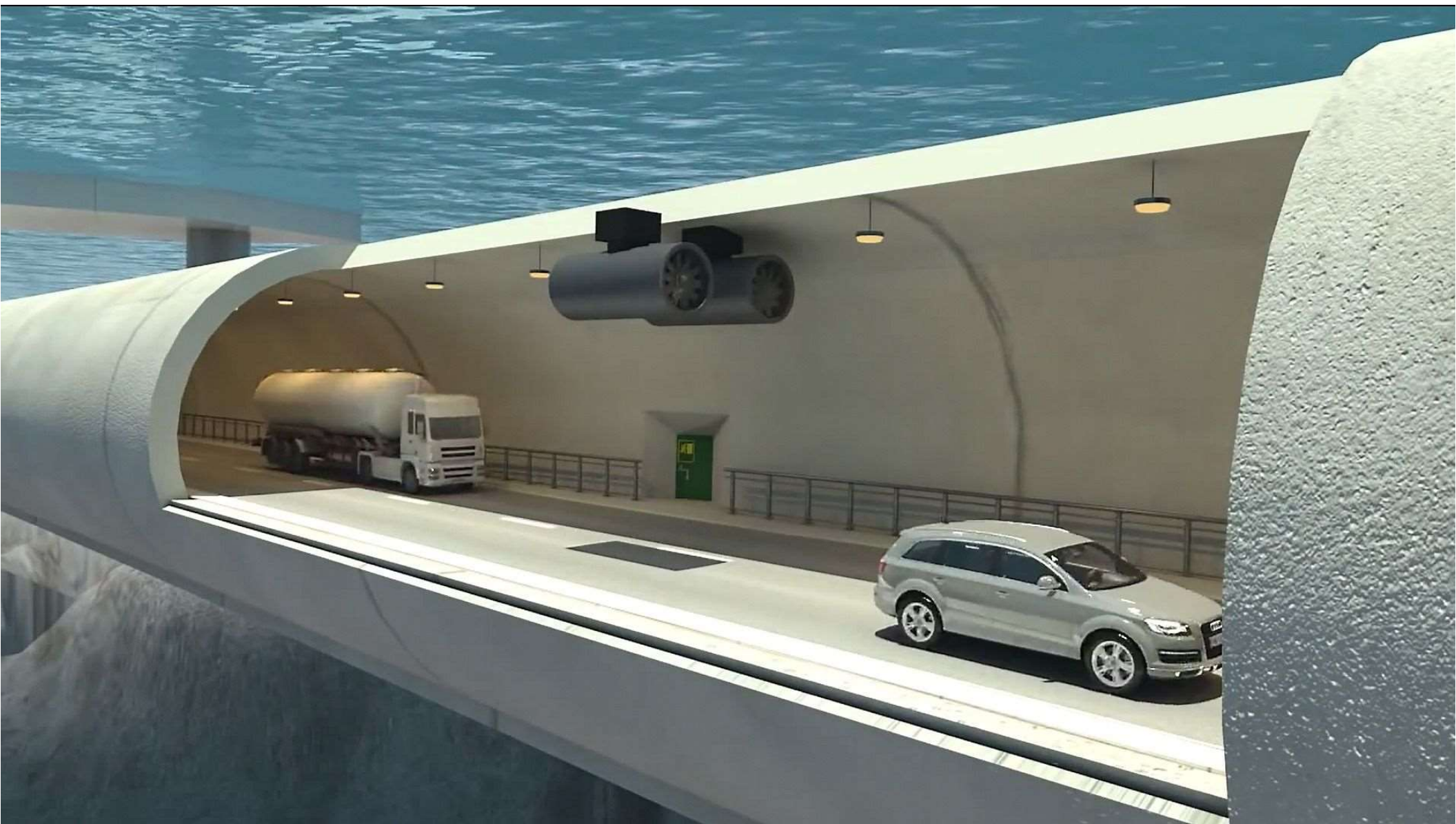


RØRBRU PÅ BUNNEN - BJØRVIKA



RØRBRU 30m UNDER VANN – unngår bølger – veldig rolig - væruavhengig





PONGTONGER RØRBRU



Dyrere enn flytebru



lorgeskart



ØVINGSOMRÅDE MARINEN BJØRNAFJORDEN

Bjørnafjorden

2 km



FI180 IITM33 67052

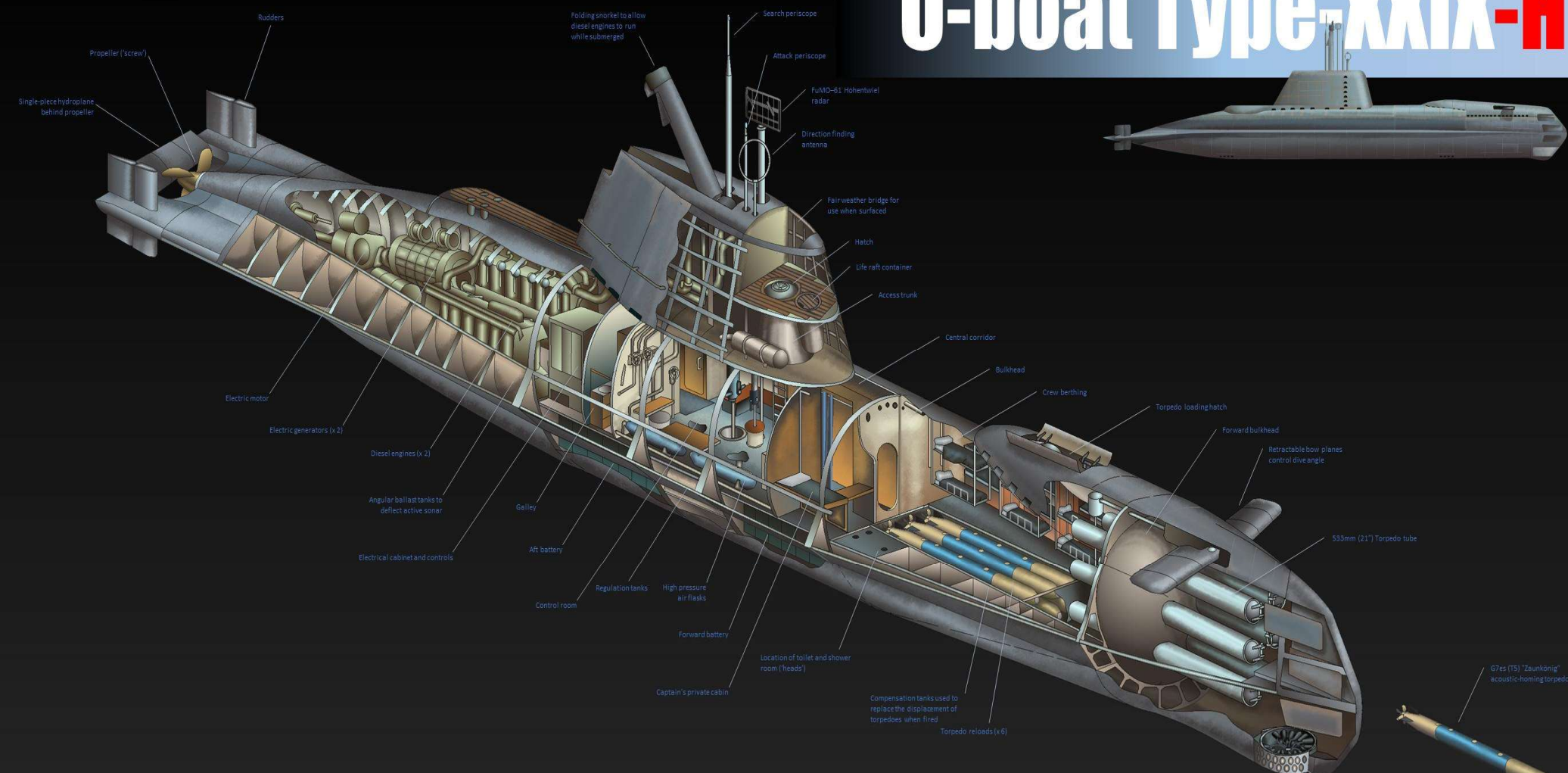
ØVINGSOMRÅDE MARINEN



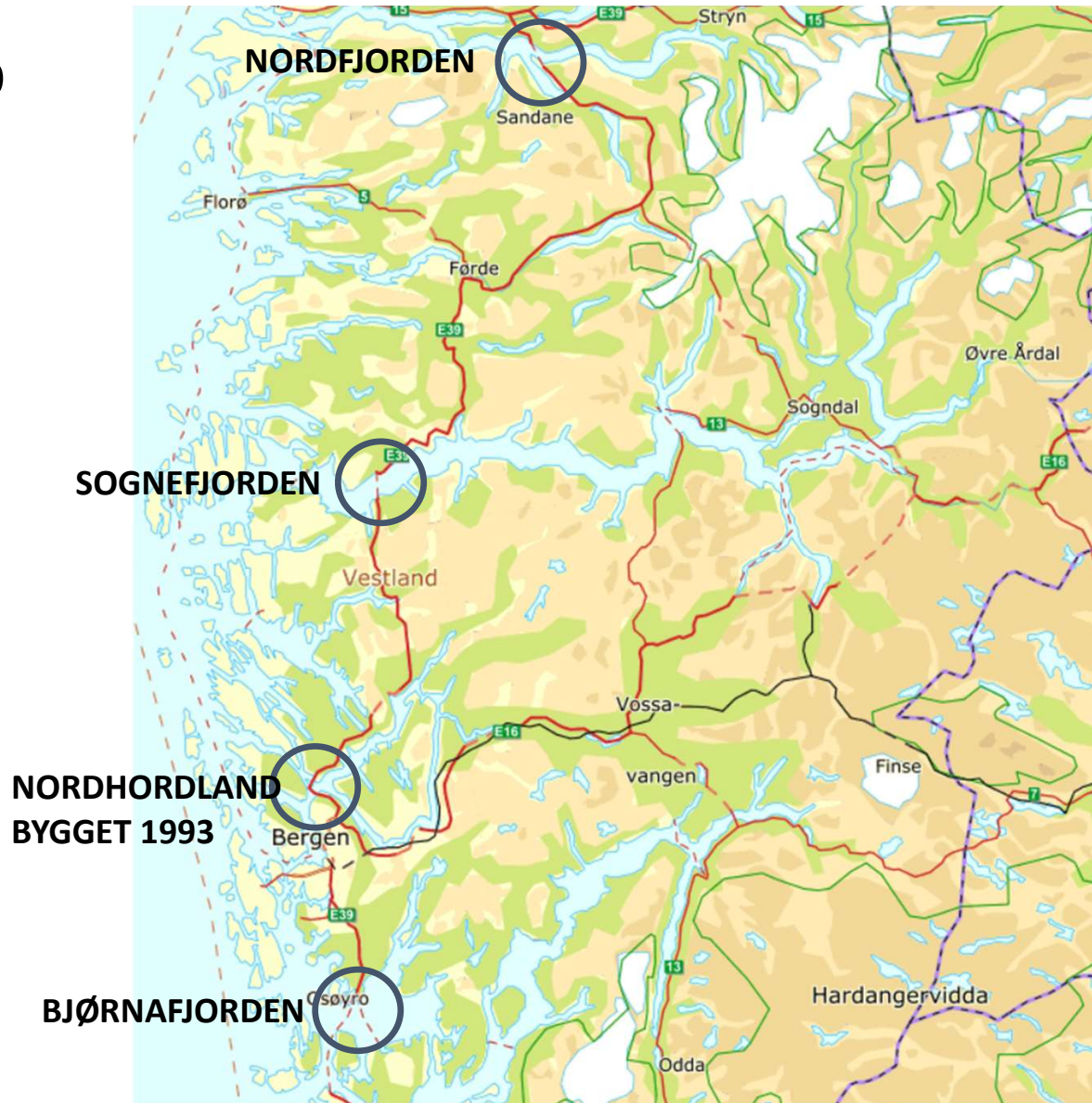
U-BÅT I BJØRNAFJORDEN



U-boat Type-XXIX-H



VESTLAND



KRYSNING SOGNEFJORDEN = BJØRNAFJORDEN

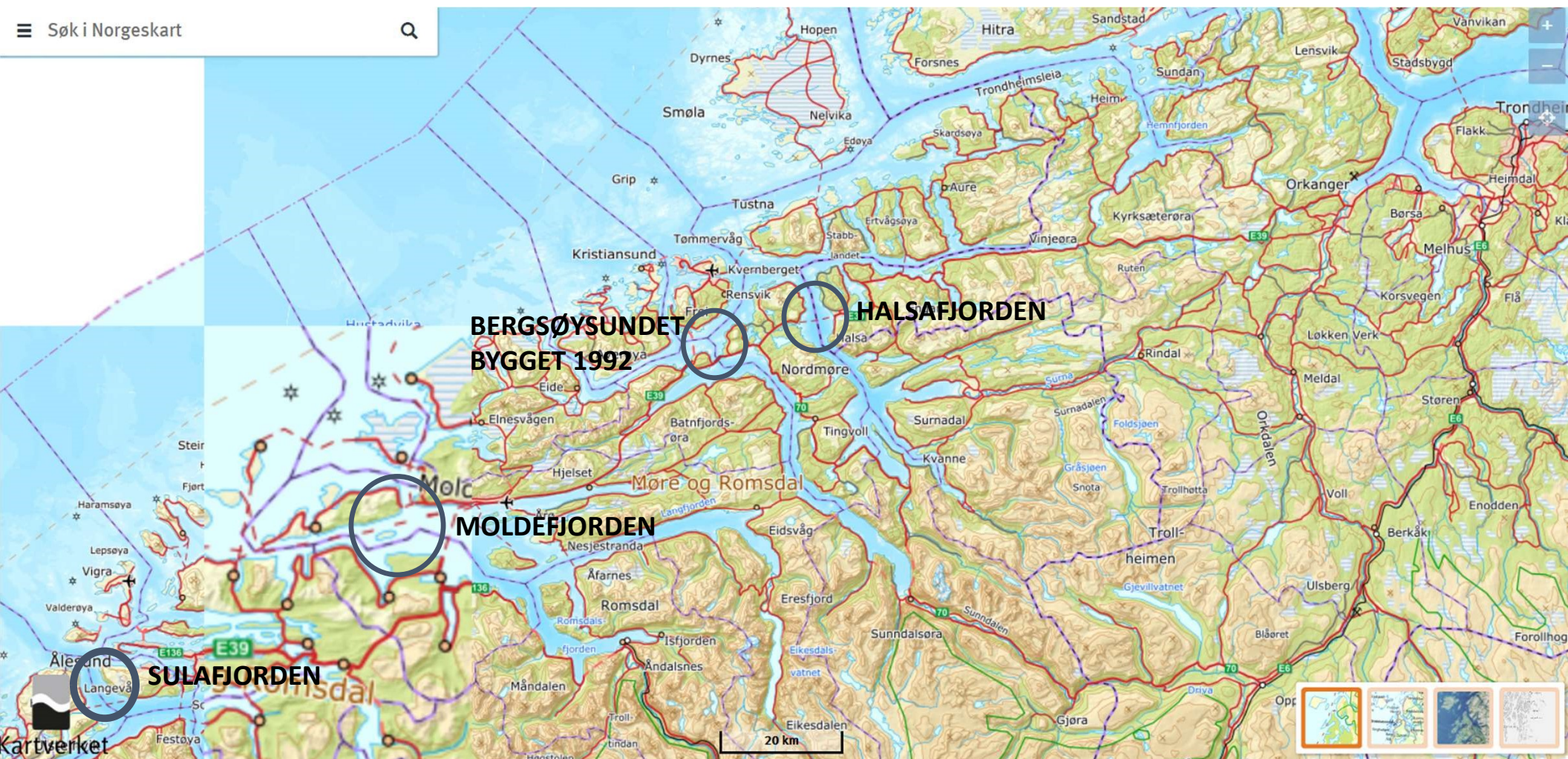


SOGNEFJORDEN KRYSSNING – 3700m - DYBDE 1300m

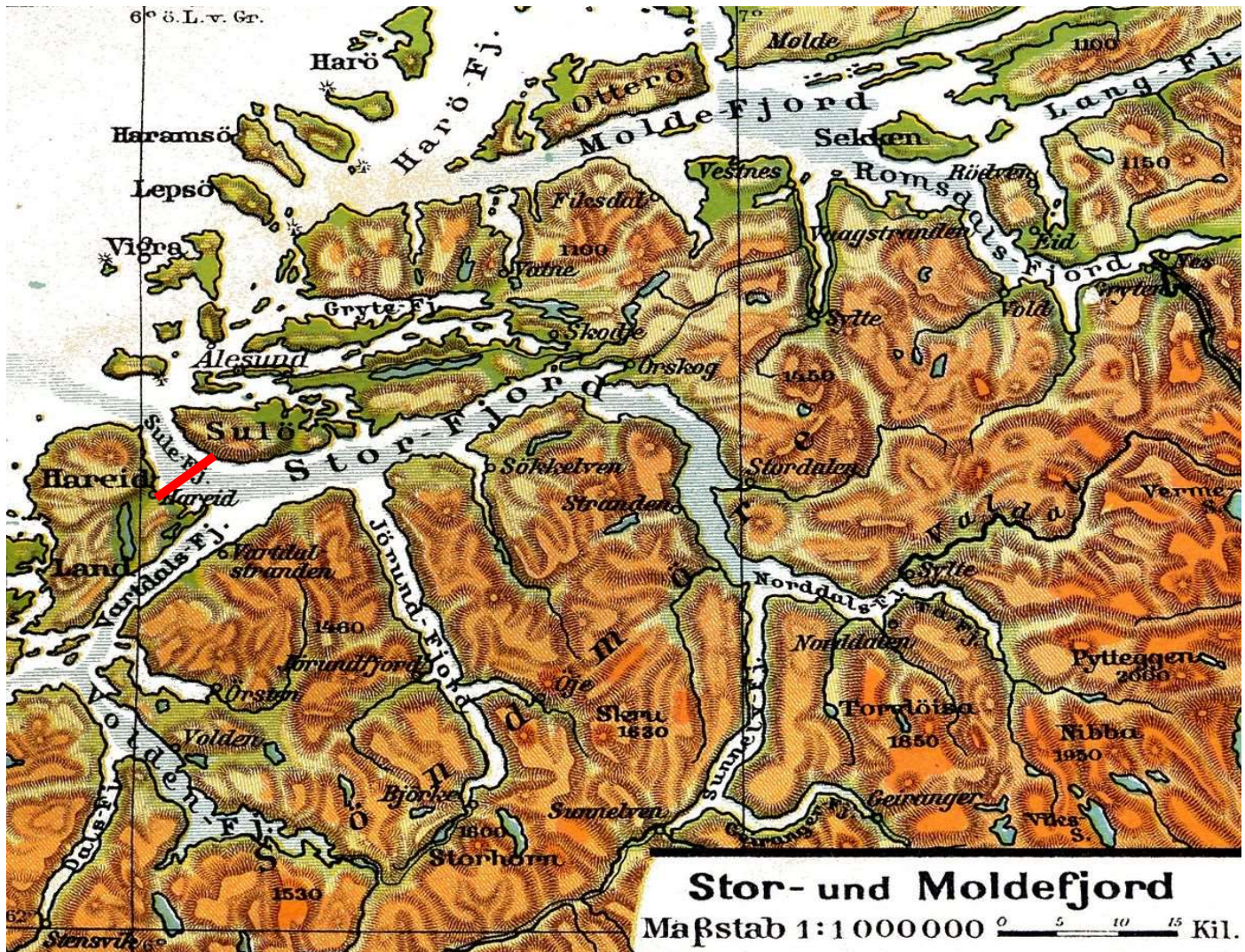


MØRE OG ROMSDAL

☰ Søk i Norgeskart

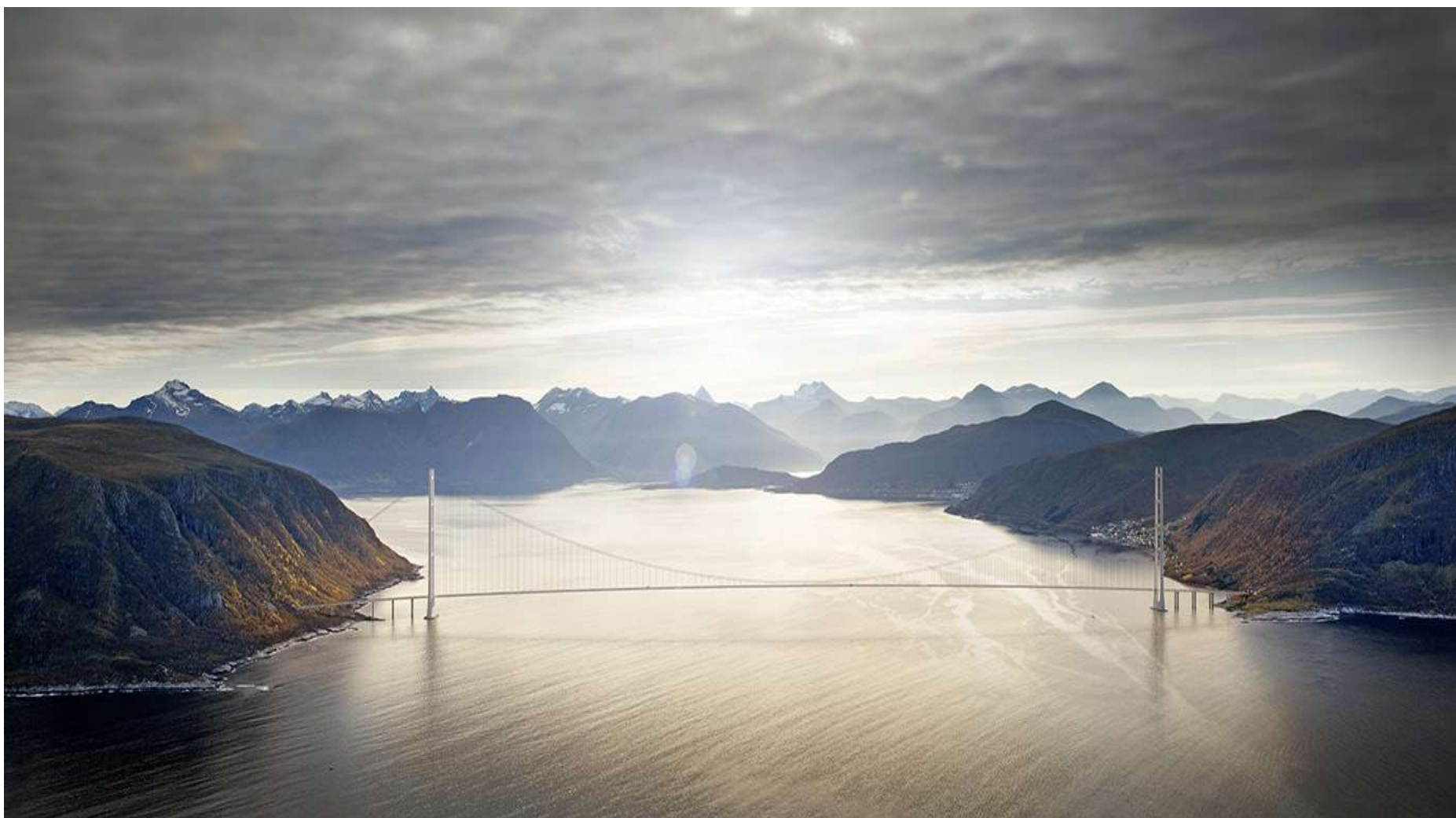


SULAFJORDEN





HENGEBRU SULAFJORDEN 2800m



RØRBRU SULAFJORDEN



Aktuelt kryssingssted HALSAFJORDEN

17.12.2015



Halsafjorden Suspension Bridge

2050 m main span

Feasibility study

The focus of the feasibility study is to achieve a workable design for the bridge.

The structural design of steel and concrete is to achieve optimum and frequency.

Wind tunnel tests

Extensive wind tunnel testing is carried out by using the National Institute of Technology (NIT) and DANAG model have been tested for flutter. Various gap between boxes have been tested. Various induced vibrations has proven to be an issue that is still being studied.

The study will be done in a generic way in order to be used for more designs than just Halsafjorden.



Flutter velocity

The combination V₀/V₁₀ does not couple, due to the low coupling coefficient.

V₀/V₁₀ and V₀/V₁₀ goes to flutter at approximately the same flutter velocity.

Effect of gap on flutter velocity



Flutter induced vibrations

Several no significant coupling between vertical and lateral vibrations have been found. Various induced vibrations have been studied.



Quick recap on aerodynamic stability problems

Static divergence
Governed by the critical frequency and the slope of C_m .

Galloping
Governed by the slope of C_m . Not a problem on bridge girders.

Dynamic stability limit in torsion
 A_2^* has to be positive.
 A_2^* is always negative on flat plates.

Flutter
Coupling of vertical and torsional modes. Governed by aerodynamic and aerodynamic derivatives.

$$A_2^* = \frac{1}{2} \left(\frac{C_m}{C_d} \right) \left(\frac{V}{V_0} \right)^2 \left(\frac{L}{B} \right) \left(\frac{1}{f_n} \right) \left(\frac{1}{f_{n+1}} \right)$$

Design basis

Load factors and traffic loads
Eurocode traffic loads are limited to 200 m in National Appendix. Eurocode traffic loads are limited to 200 m in National Appendix. Eurocode traffic loads are limited to 200 m in National Appendix.

Wind speed
Mean wind speed is estimated at 20 m/s at 10 m above sea level, after 1.5 years of wind measurements on site.
Critical wind speed is estimated as:

$$V_{10} = 1.0 \cdot 20 \cdot 1.0 = 20 \text{ m/s} = 60 \text{ km/h} = 100 \text{ mph} = 61.3 \text{ m/s}$$

Outline of the bridge

- Twin box girder
- 30 m between hangers
- Cross beam at each hanger
- ø100 mm hangers as full locked coil ropes
- 265 m high concrete towers
- ø6.75 m suspension cables
- 0.375 m each
- 1860 MPa tensile strength
- Rock anchor at both ends



Eye transmiss

Total mass 115 000 kg/m
Mass moment of inertia 2 000 000 kg/m²/m



Future work

- The next phase is a preliminary study
- On-site geological surveys
- R&D to get a better understanding of aerodynamic stability problems
- Preliminary design of the main components to obtain a cost estimate

HALSAFJORDEN



Det pågår nå et betydelig rehabiliteringsarbeide på E39 Bergsøysundbrua.







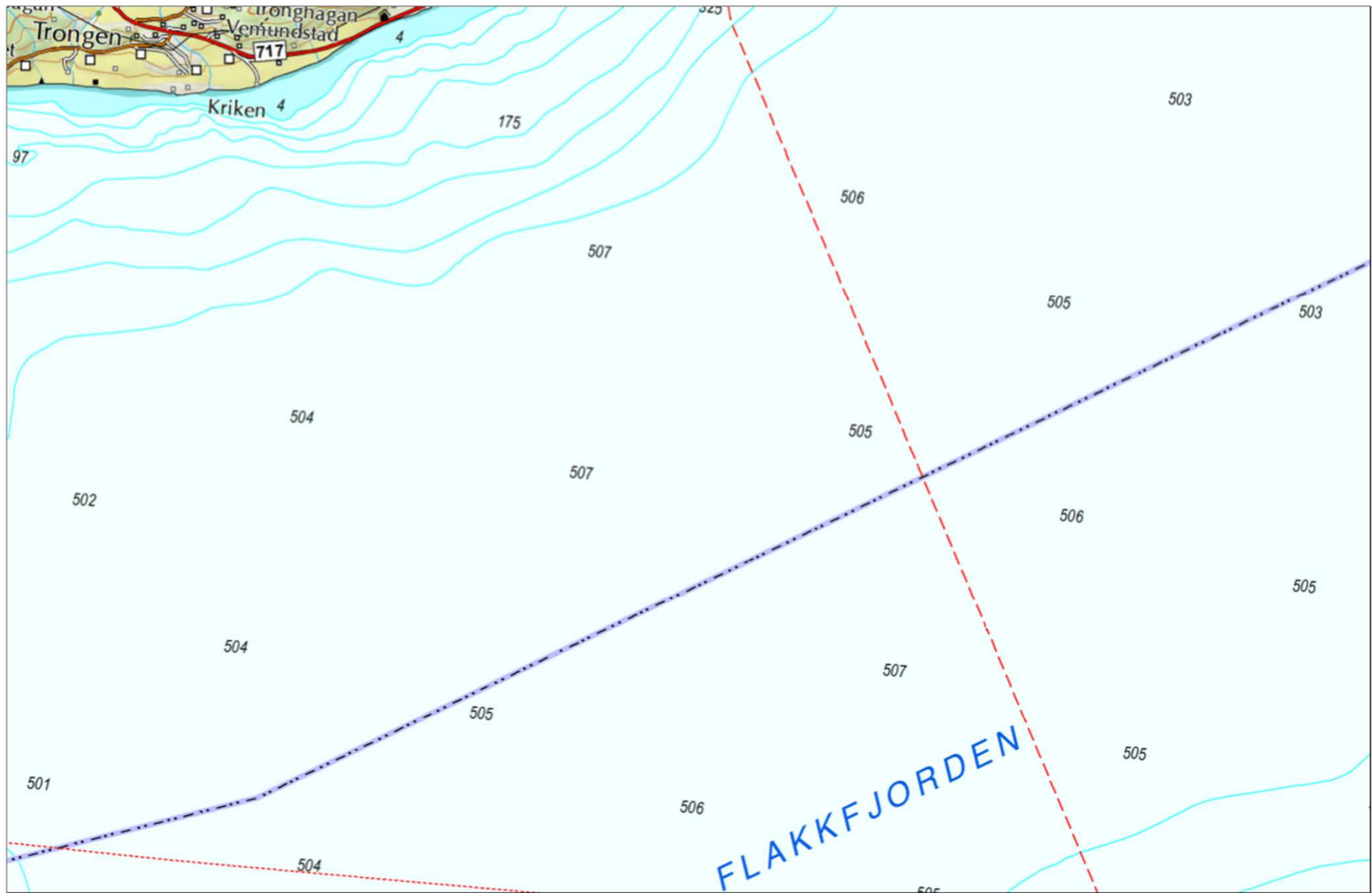


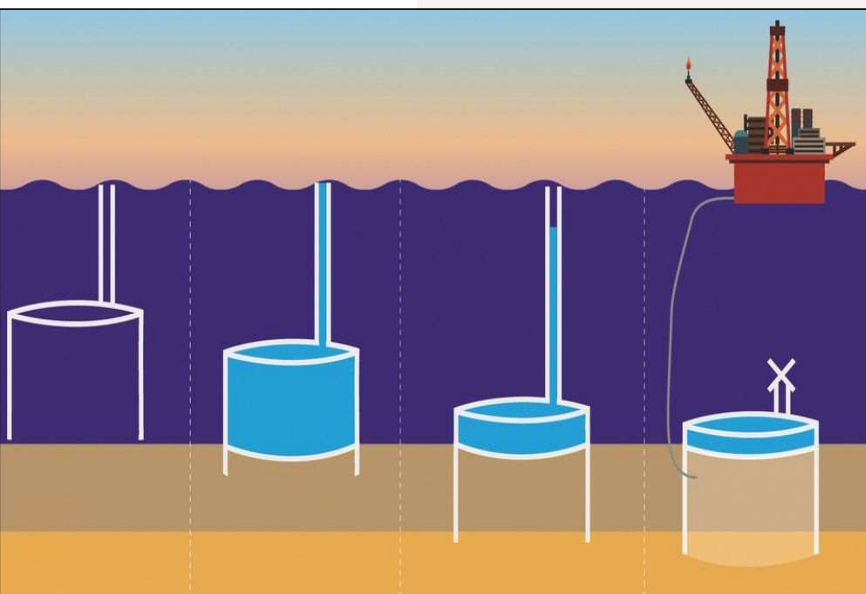
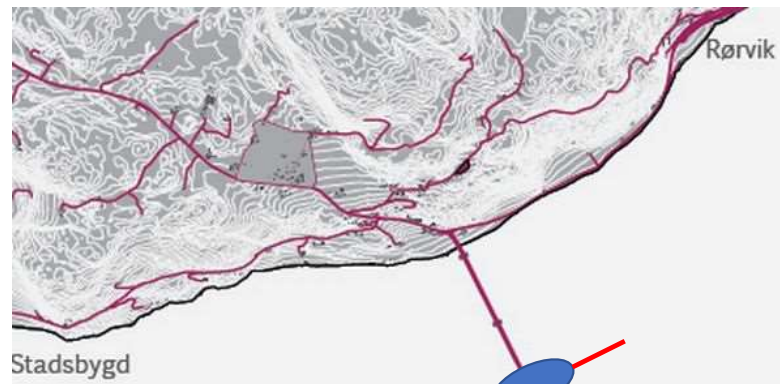
DYBDEKARTLEGGING EKKOLODD - NGU



BATYMETRI

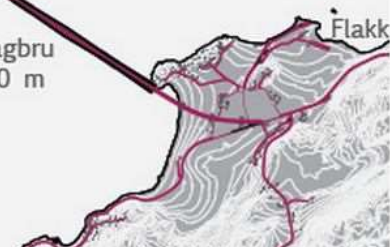






Sideforankret flytebru
5 300 m

Skråstagbru
1 400 m



TRONDHEIMSFJORDEN - RAMBØLL



