



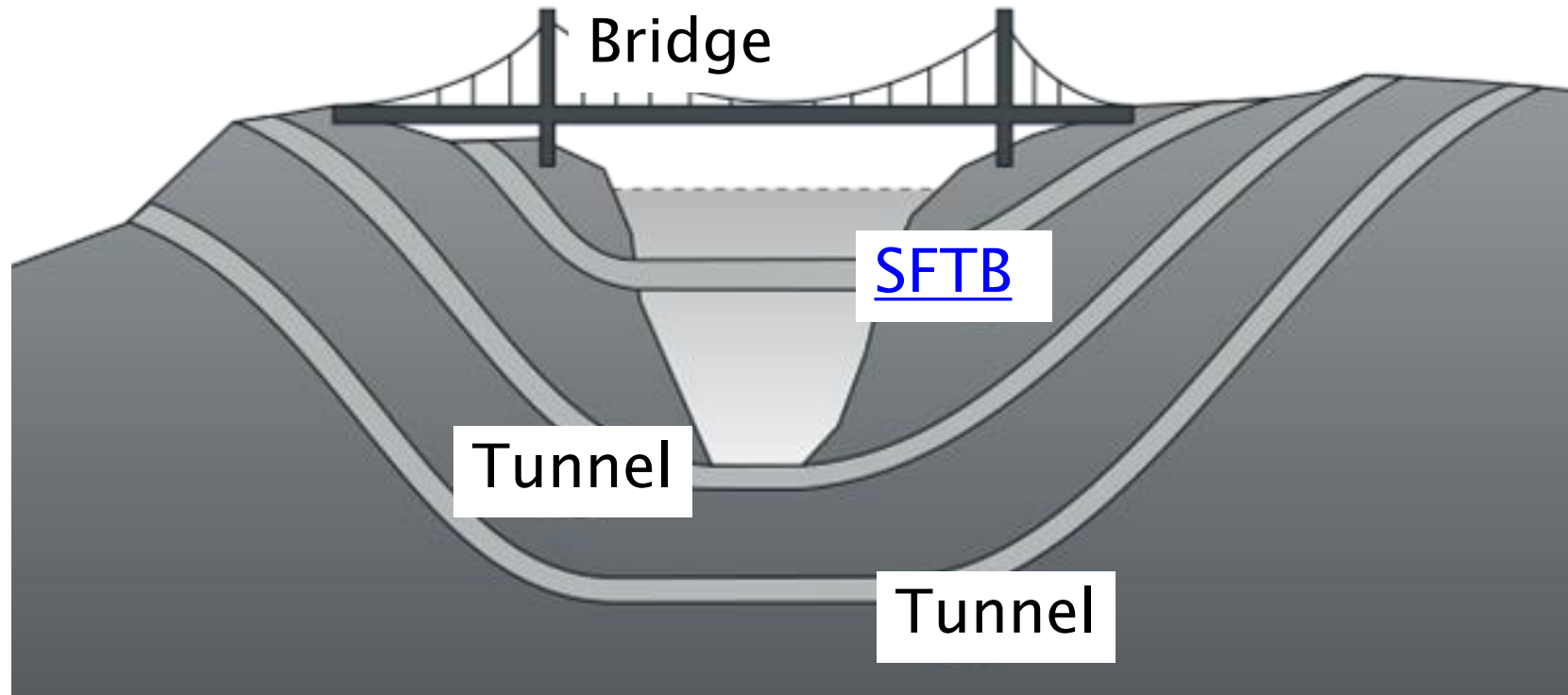
A new possibility for crossing: The Submerged Floating Tube Bridge



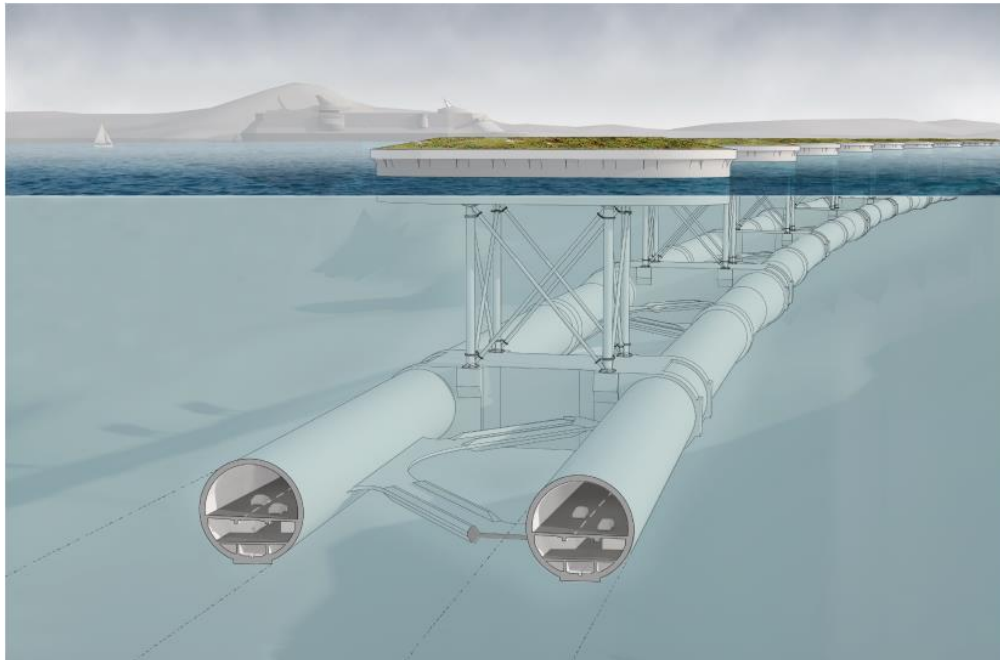
Statens vegvesen – study for the SFTB in Bjørnafjord



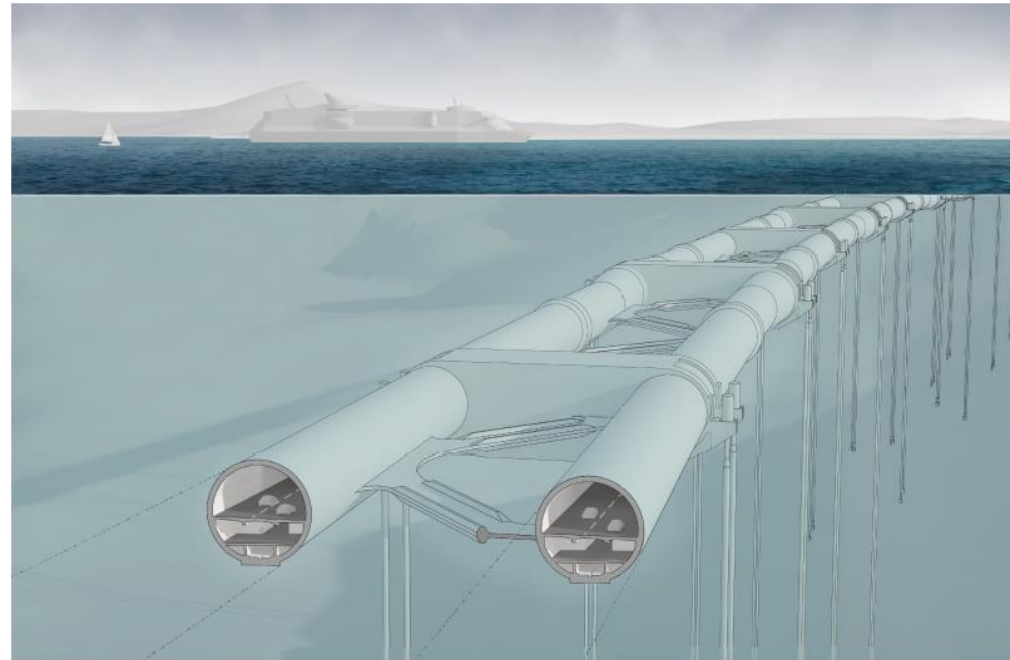
What is a Submerged Floating Tube Bridge?



Geometry and Vertical stabilizing system: pontoons or tethers



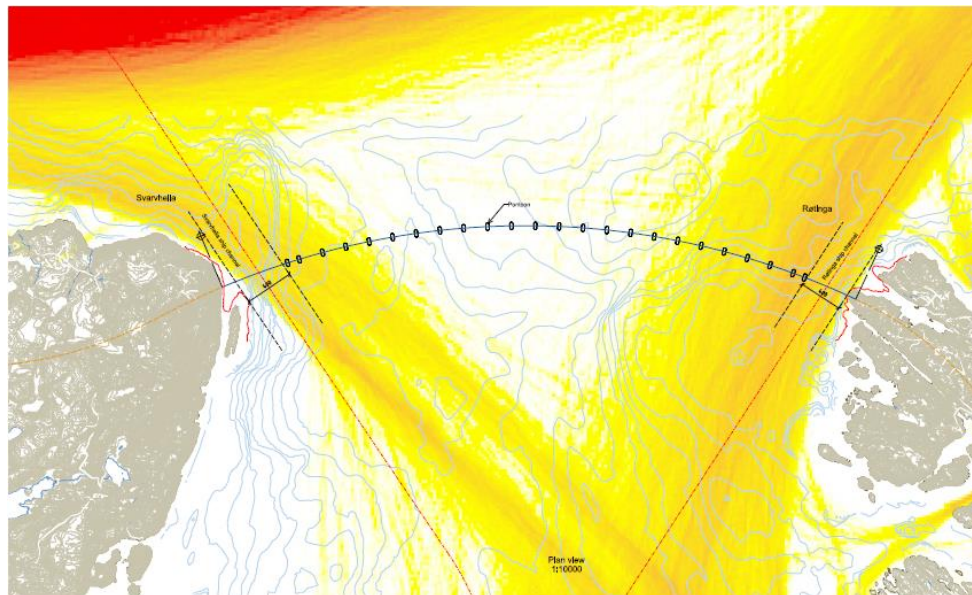
SFTB with pontoons – Statens vegvesen



SFTB with tethers – Statens vegvesen



Pontoons: pros and cons



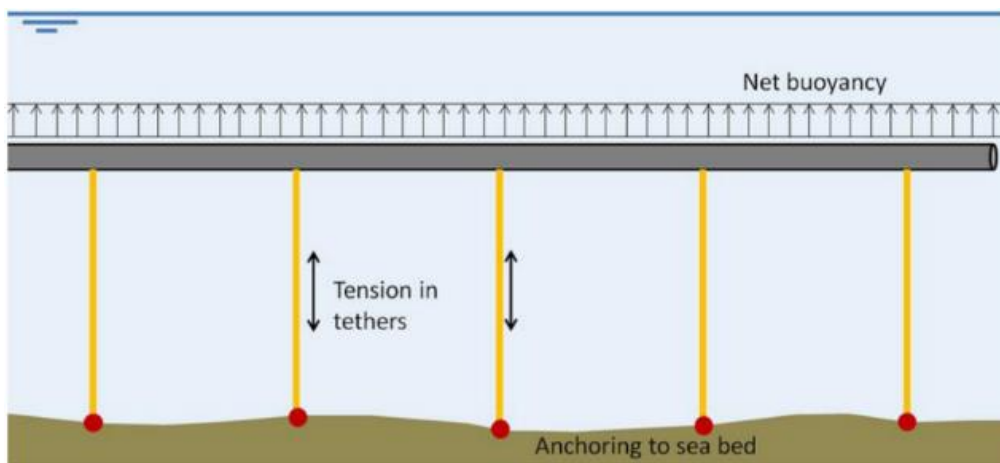
SFTB fairways and vessels traffic– Statens vegvesen



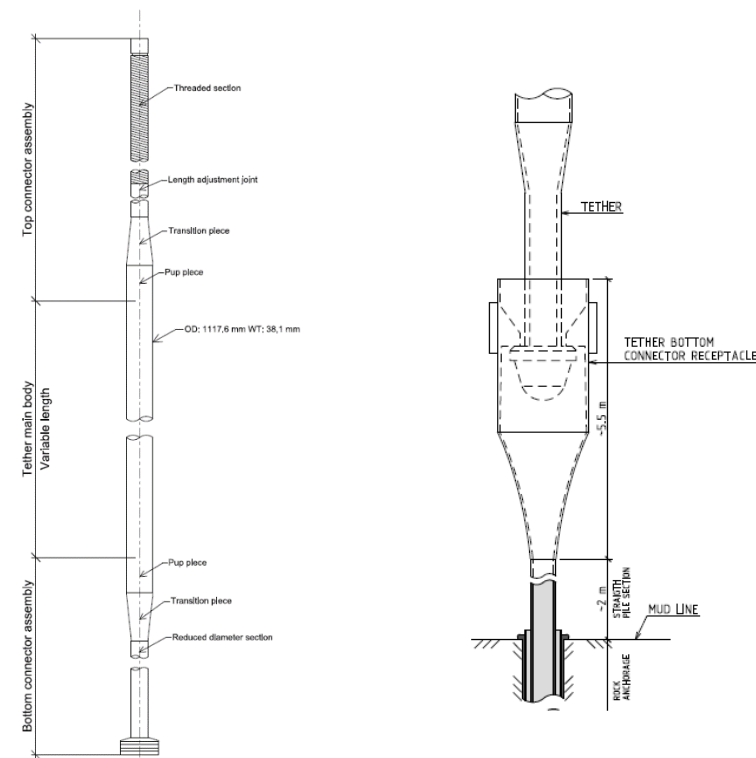
Statens vegvesen – study for the SFTB in Bjørnafjord



Tethers: pros and cons



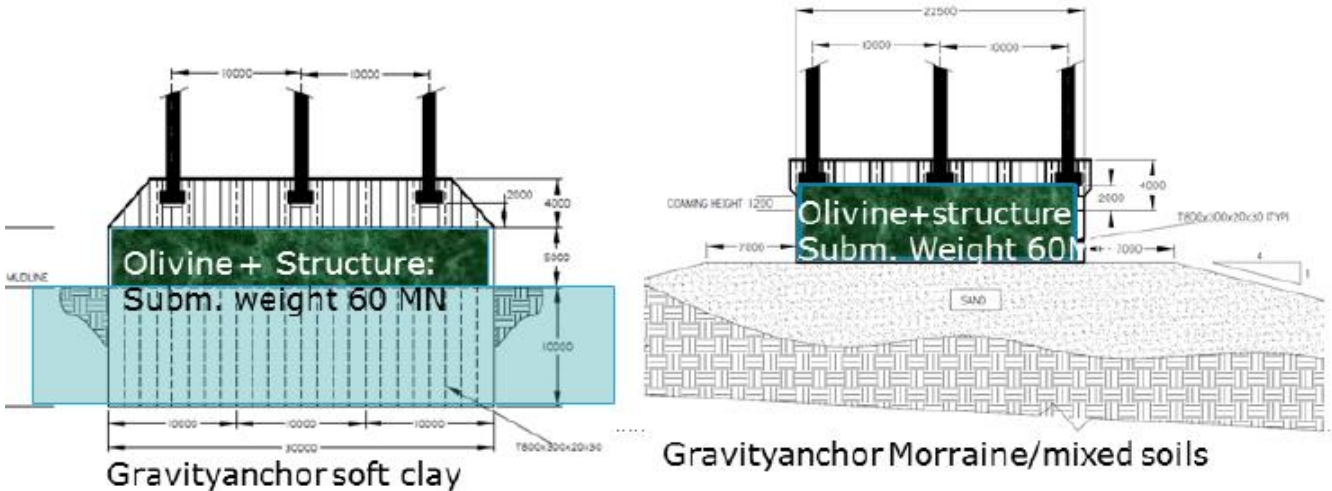
Scheme for a SFTB with tethers– Statens vegvesen



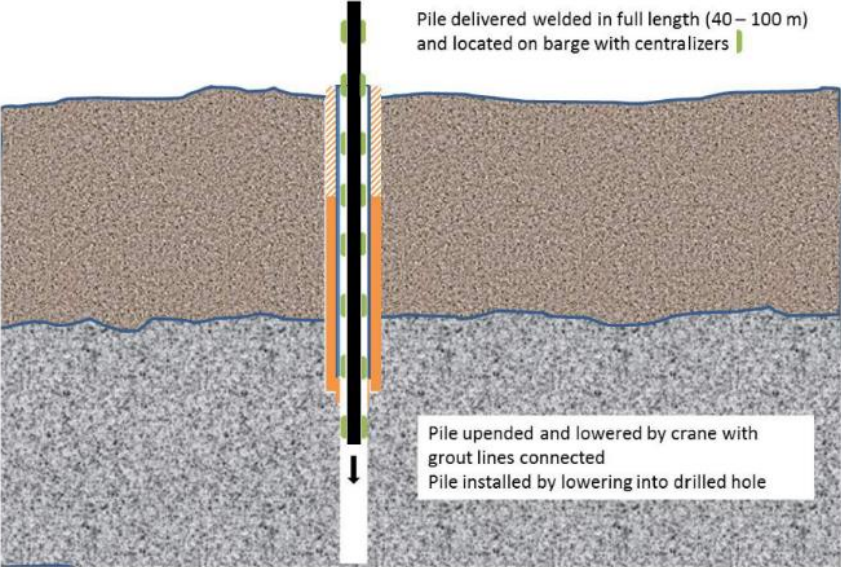
Study for drilled and grouted rock anchors– Statens vegvesen



Foundations



Study for foundations – Statens vegvesen



Study for drilled and grouted rock anchors– Statens vegvesen

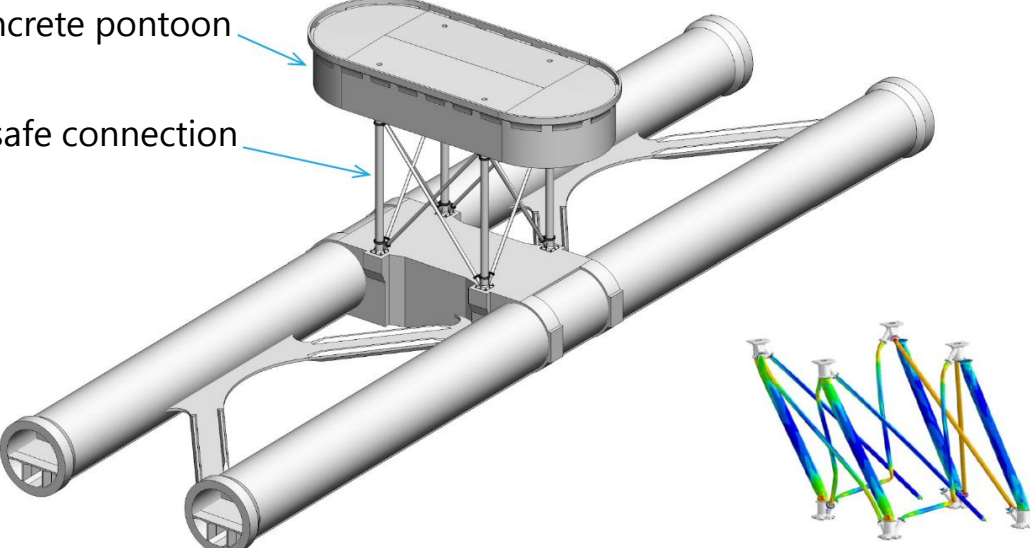




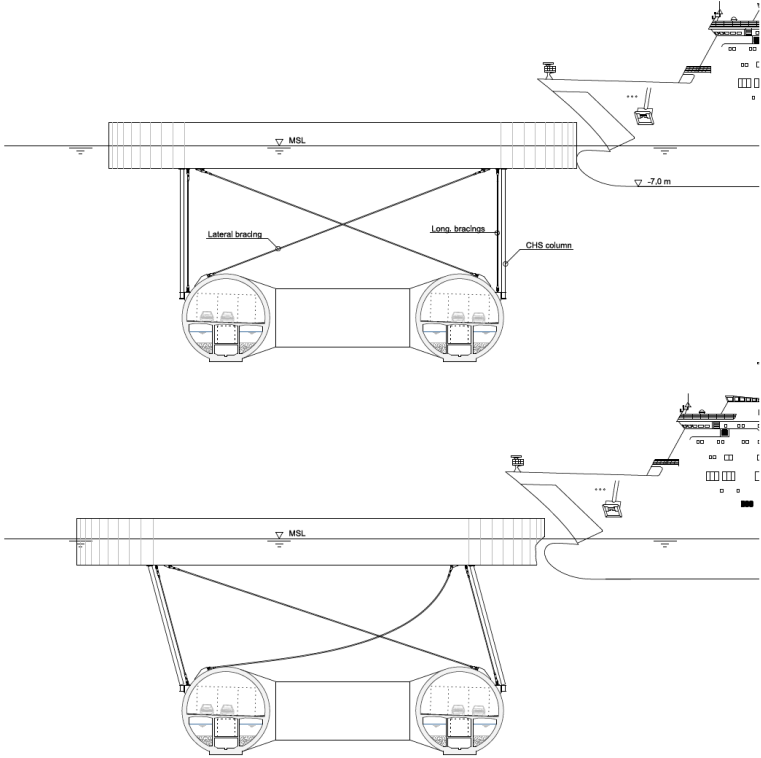
Ship collisions

Concrete pontoon

Fail-safe connection



Dr. Techn. Olav Olsen – ship impact

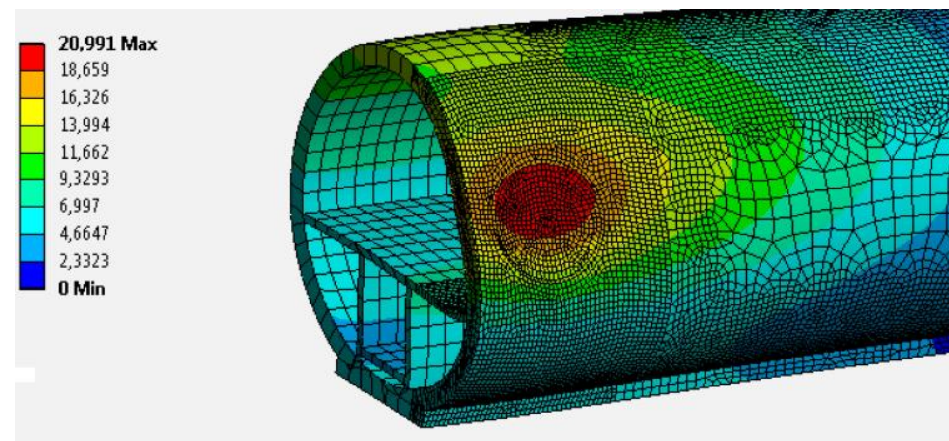
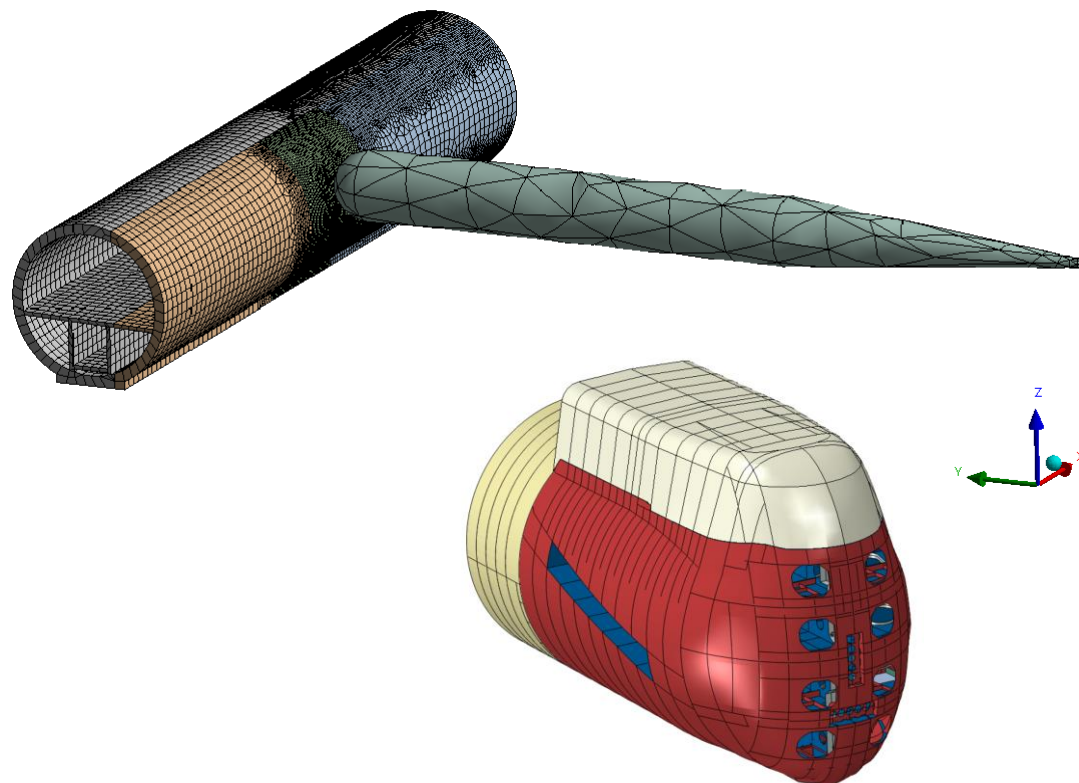


Study for a weak link for the Bjørnafjord crossing – Statens vegvesen





Submarine collisions



FEM model for submarine collision and for submarine– Statens vegvesen





Fires and explosions

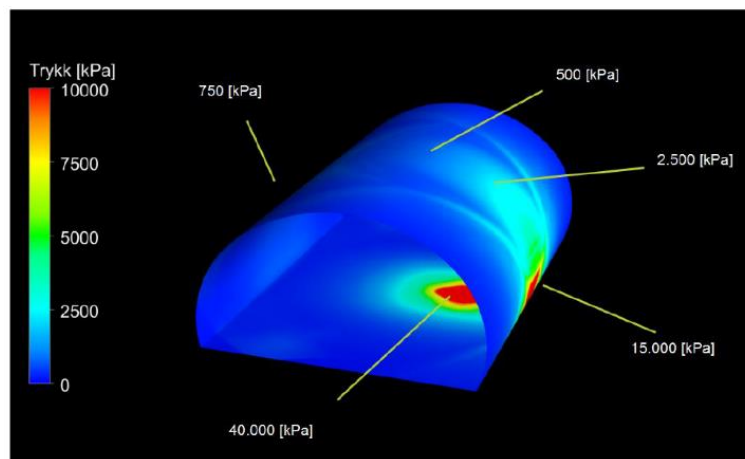
Fire:

NPRA handbook design load: 300 MW for 2 hours

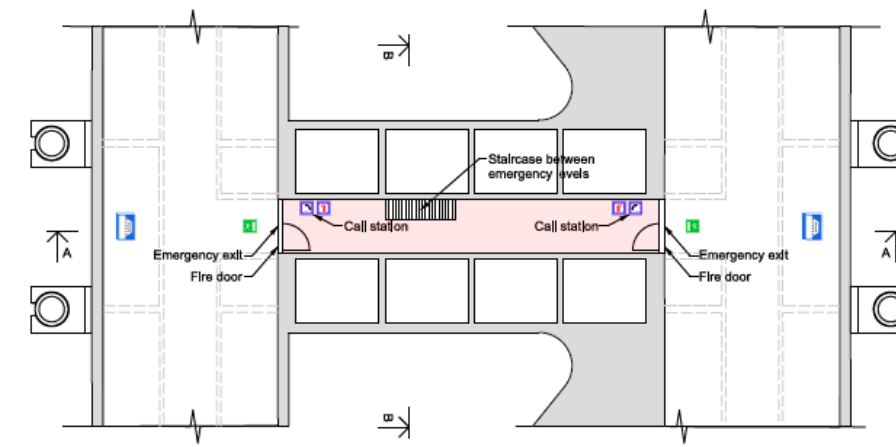
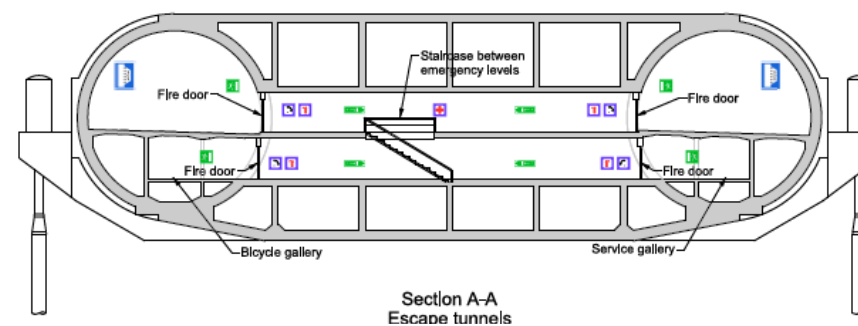
Explosion:

Gas deflagration most likely

Design load: 300 kPa



Peak pressures from TNT detonation



Plan view
SFTB safety exits – Statens vegvesen

Robustness: ability of the structure to withstand unexpected situations

- A ship impact towards one pontoon. The pontoon is not removed during this event. The ship impact is modelled as a time domain transient dynamic analysis with correct mass, stiffness and damping relations
- Instantaneous loss of one pontoon. No time for traffic redirecting or limitations are assumed, i.e. full traffic load in an accidental state. After this event the traffic load is reduced and the structure is controlled in a regular ultimate limit state
- Sinking ship hitting the tubes. An approximation of maximum vessel weight is found
- Explosion in the tubes in combination with other loads
- Flooding in one of the ballast chambers
- Loss of one tether

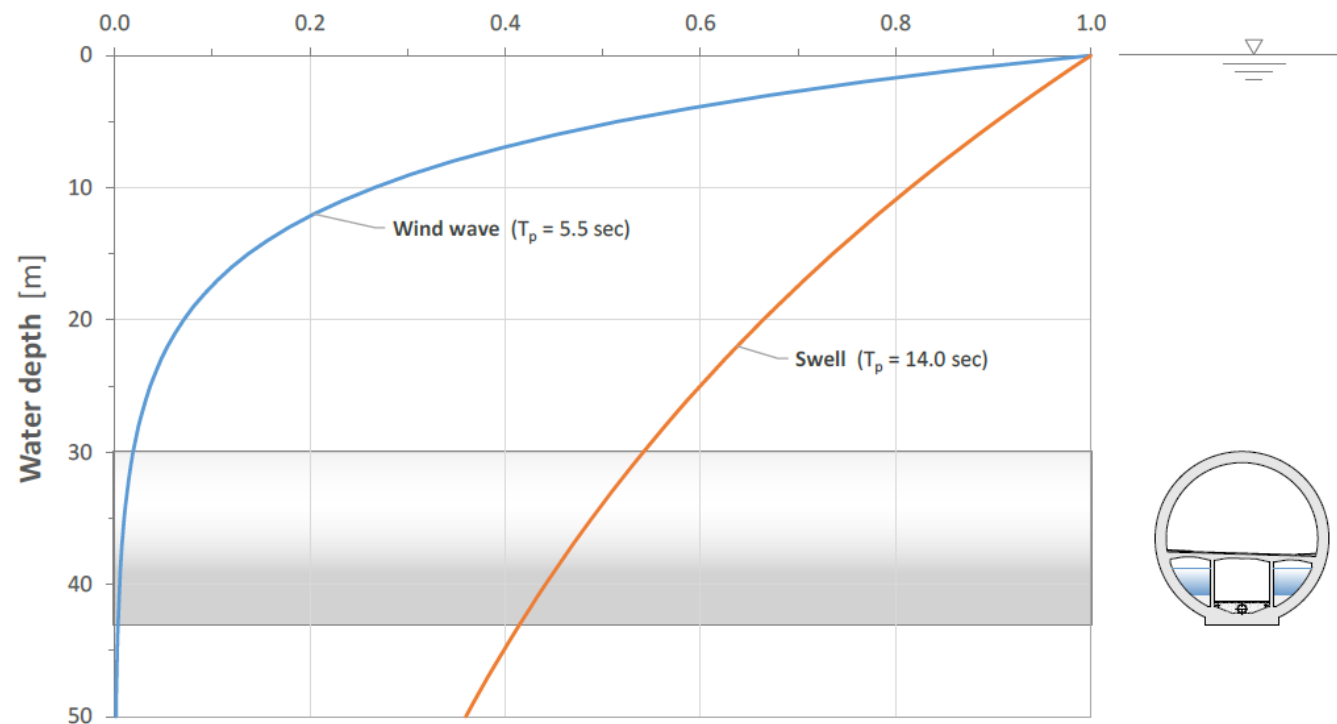
ROBUSTNESS How much you can take before you go down



Wade Austin Ellis – grayscale photo of boxing sparring



Natural reduction of main sea loads

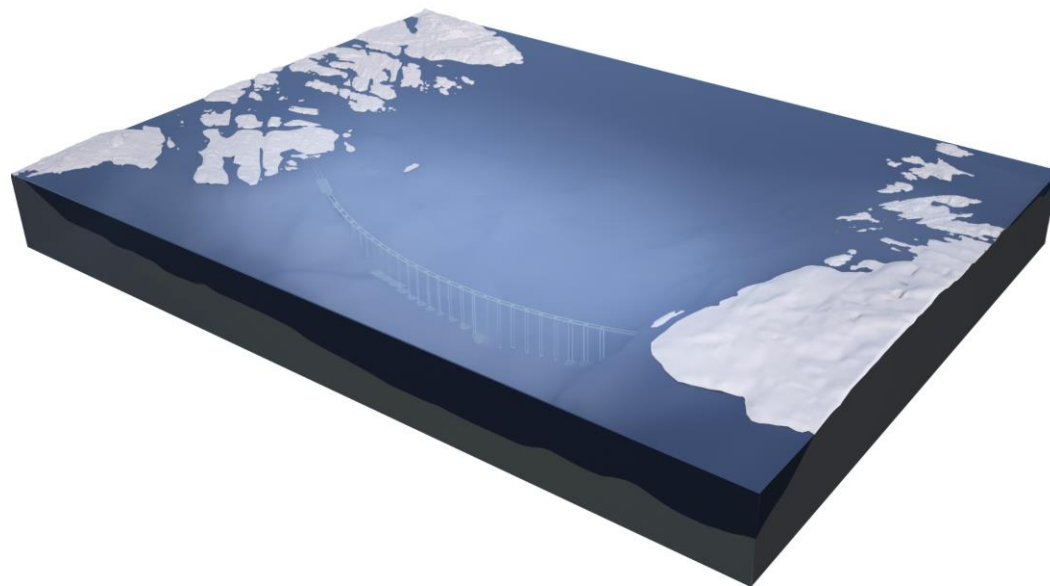


**ZERO DOWNTIME
FOR THE CROSSING !**

Wave load with water depth (normalized) for the Bjørnafjord study– Statens vegvesen



Landscape and acoustic impact



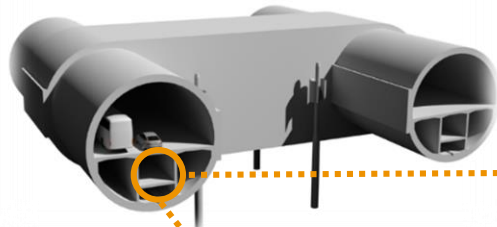
Submerged Floating Tube Bridge in Bjørnafjorden – Statens vegvesen



SFTB for crossing the Bjørnafjord– Statens vegvesen



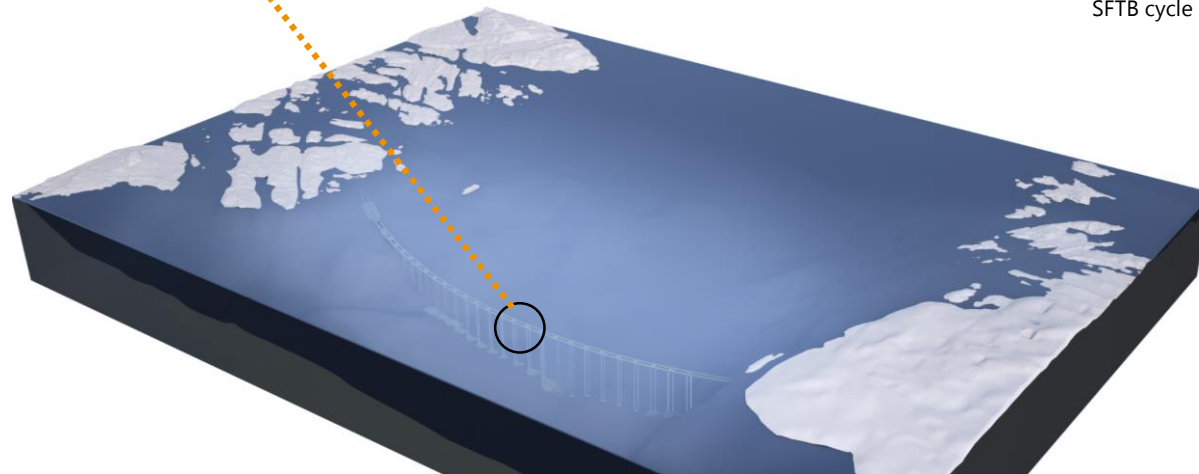
Pedestrian path



SFTB cross section



SFTB cycle and pedestrian path – Statens vegvesen



Submerged Floating Tube Bridge in Bjørnafjorden – Statens vegvesen



Why never built?





Feasibility studies:

Høgsfjord
1996

Sognefjord
2011



Submerged Floating Tube Bridge in Sognefjord – Statens vegvesen



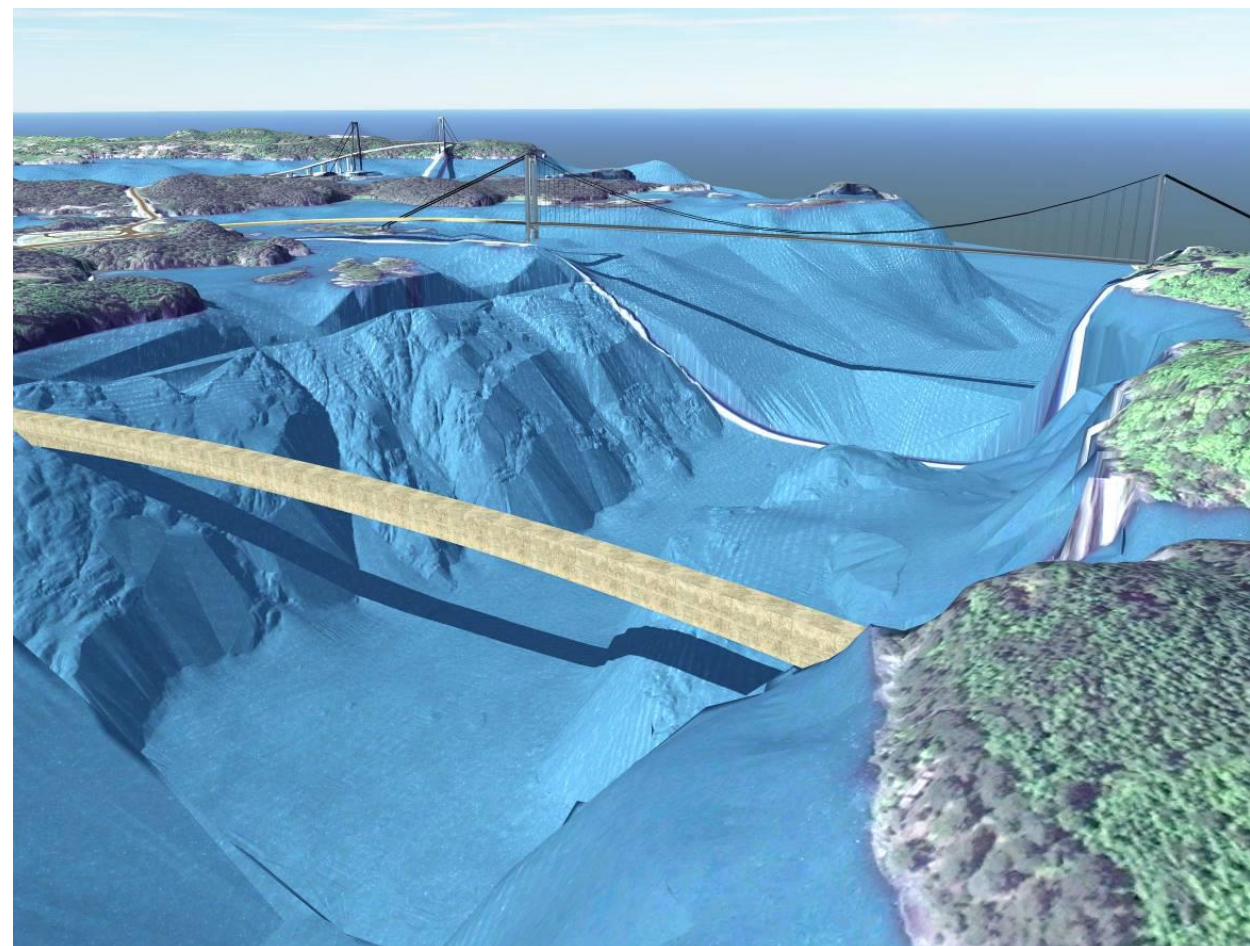
Statens vegvesen



Bjørnafjord
2016

Digernessundet

Sulafjord

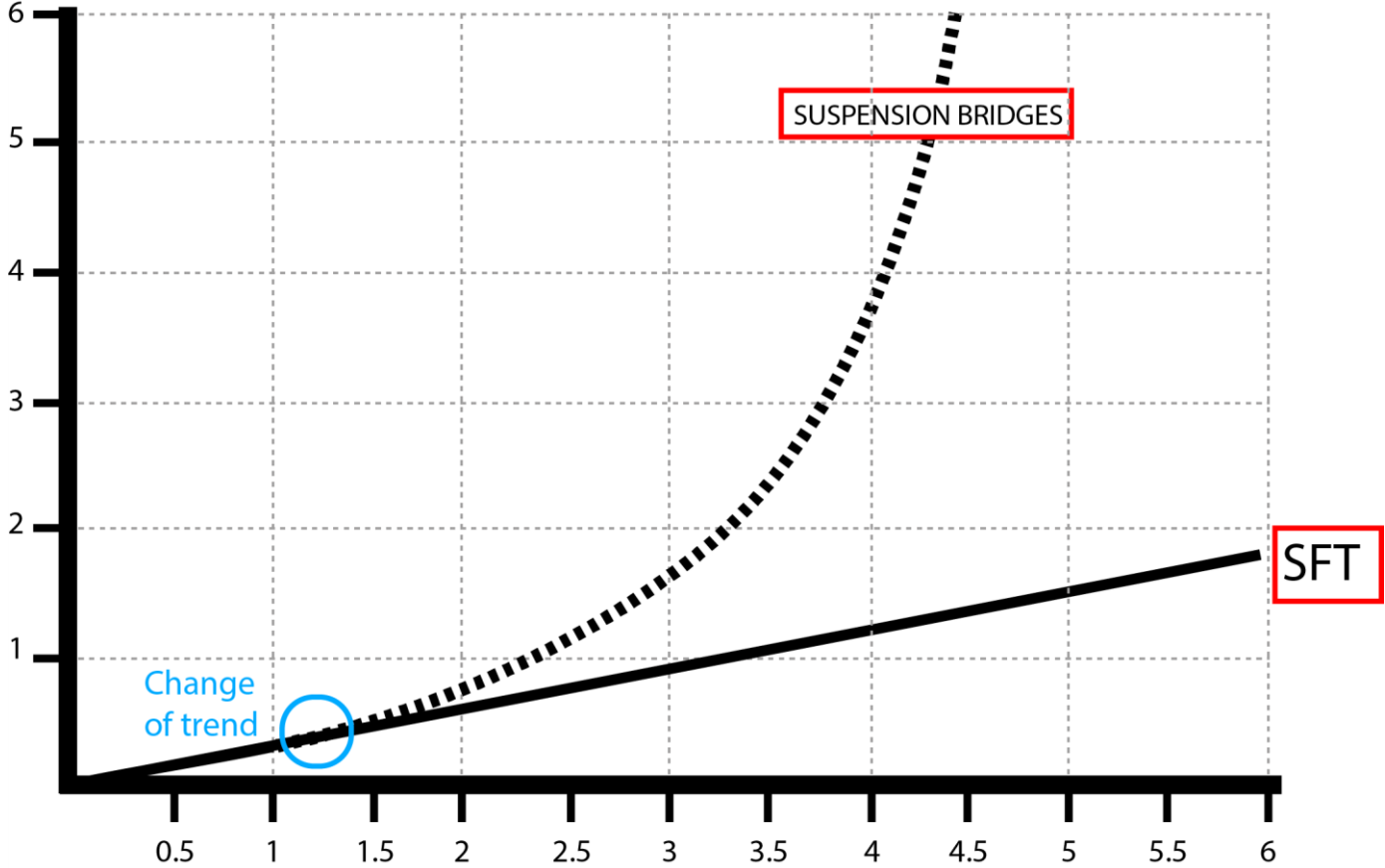


Study for crossing the Digernessundet with a SFTB – Statens vegvesen





Costs





The development in the offshore structures



Heidrun Tether Tow & Installation -Holwech et al., FPS 1997 & Engebretsen et al., OTC 2002

Dissemination:

Development of a submerged floating tube bridge for crossing of the Bjørnafjord; Multi-Span Large Bridges; Porto 2015

Vertical stiffness for tube bridges: Comparing pontoons and tethers; IABSE; Geneve 2015

E39 - nuove tipologie strutturali per l'attraversamento dei fiordi norvegesi; Trasporti e cultura; Italia 2015

The use of wind tunnel facilities to estimate hydrodynamic data; Experimental Fluid Mechanics; Prague 2015

Mega bridges for the fjord crossing in Norway; Bridge design & Engineering; 2015

The Submerged Floating Tube Bridge: The invisible bridge crossing the Bjørnafjord; IABSE; Stockholm 2016

The Submerged Floating Tube Bridge: Design Philosophy and Concept Development; IABSE; Stockholm 2016

Hydrodynamic loads on a submerged floating tunnel bridge induced by a passing ship or two ships in maneuver in calm water; OMAE; Busan 2016

Basic design for a Submerged Floating Tube Bridge across the Digernessund; IABSE; Vancouver 2017

A submerged floating tube bridge concept for the Bjørnafjord crossing – marine operations; OMAE; Trondheim 2017

Simplified hydrodynamic design procedure of a submerged floating tube bridge across the Digernessund of Norway; OMAE; Trondheim 2017

Global Analysis of Submerged Floating Tube Bridge (SFTB): The Design Case of Crossing the Bjørnefjord in Norway; World Tunnel Congress; Bergen 2017

Submerged floating tunnels subjected to internal blast loading; Transport Research Arena; Vienna 2018

The Submerged Floating Tube Bridge as an alternative for a crossing: pros and cons; IABSE; Nantes 2018



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19th IABSE Congress Stockholm, 21-23 September 2016

Challenges in Design and Construction of an Innovative and Sustainable Built Environment

The Submerged Floating Tube Bridge: The invisible bridge crossing the Bjørnafjord

Arianna Minoretti

State department, Norwegian Public Road Administration, Norway

Owners guide for SFT – ITA AITES (International Tunneling and Underground Space Association)

WG 1.2 Concrete structures in marine environment – FIB (International federation for structural concrete)



Statens vegvesen

Interest for SFTB around the world

WIRED

AARIAN MARSHALL TRANSPORTATION 07.14.16 12:00 PM

YES, A 'SUBMERGED FLOATING BRIDGE' IS A REASONABLE WAY TO CROSS A FJORD



TRATION

Forbes

Could Norwegian Engineers Really Build A Floating Tunnel In A Fjord?

HUFFPOST

ACTUALITÉS 26/07/2016 17:20 CEST | Actualisé 05/10/2016 16:44 CEST

Entre le tunnel sous-marin et le pont, la Norvège pourrait expérimenter les tunnels flottants

Nadège El Ghomari Le HuffPost

ifanr 爱范儿



挪威人疯了，打算让海底隧道“浮”起来

新创
2016-07-26 12:26



BBC

ACTUALIDAD

LA STAMPA

futurezone
TECHNOLOGY NEWS

...

丁客邦

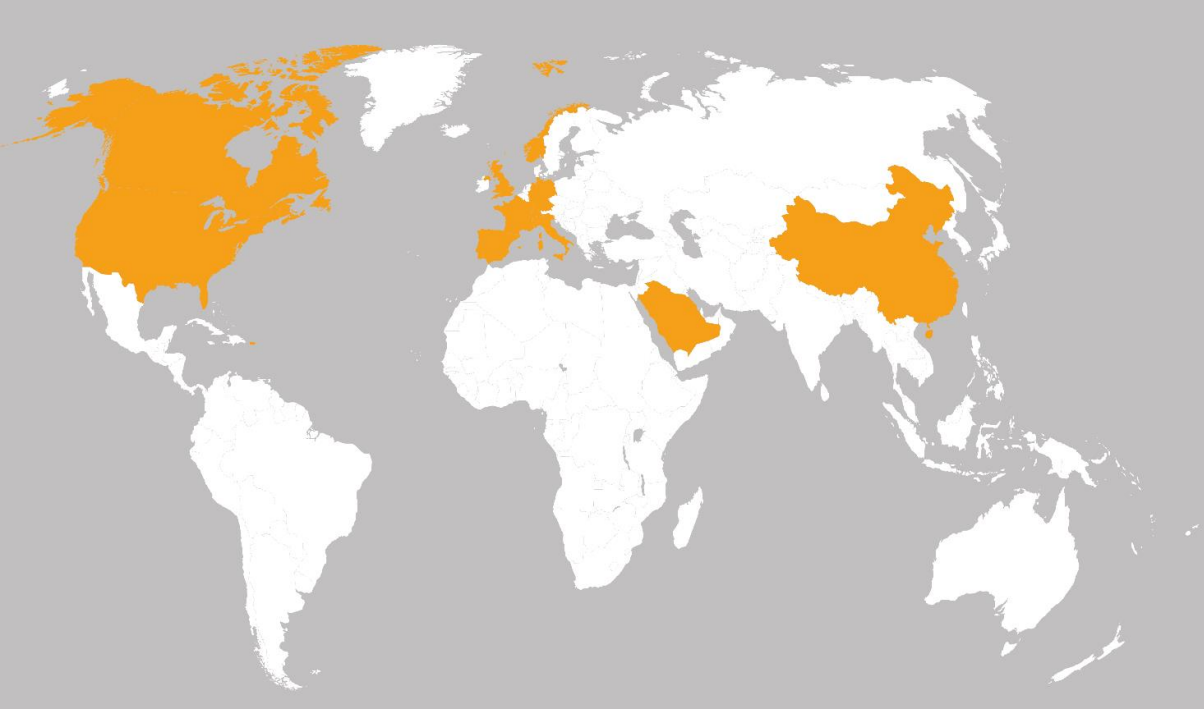
iNews TV

Daily Mail

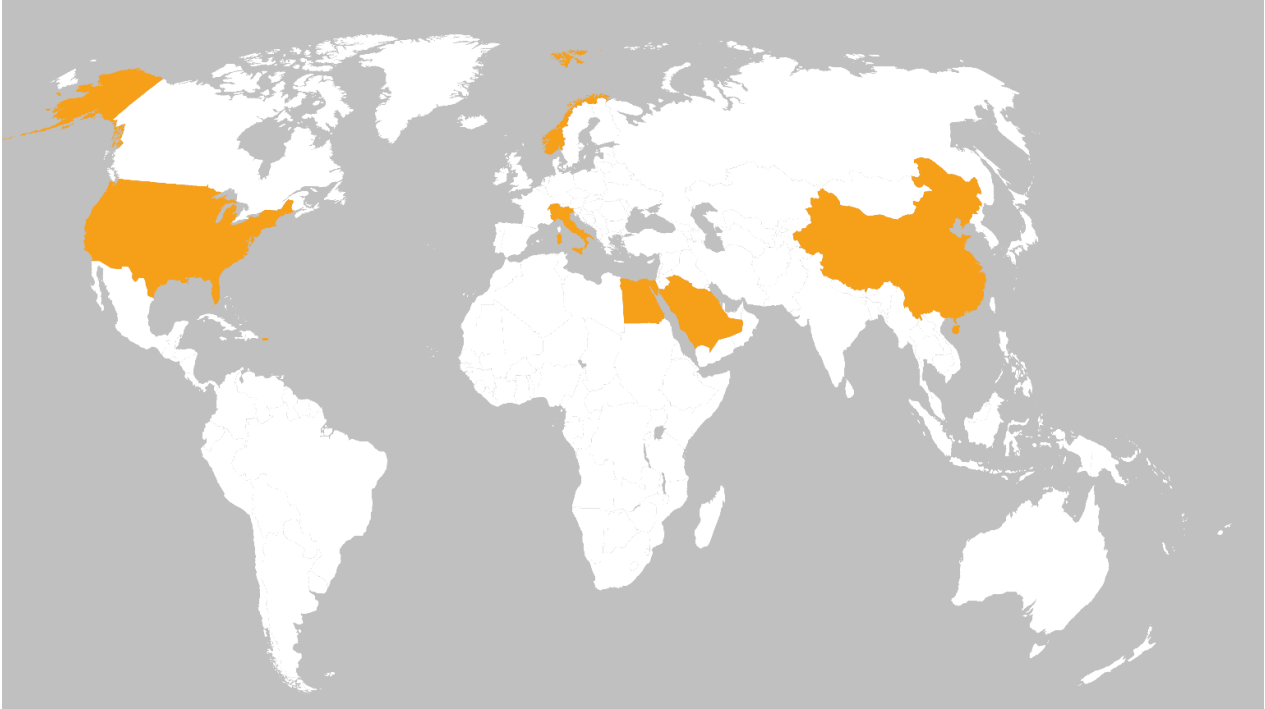
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Projects for SFTBs around the world



Map 1: articles

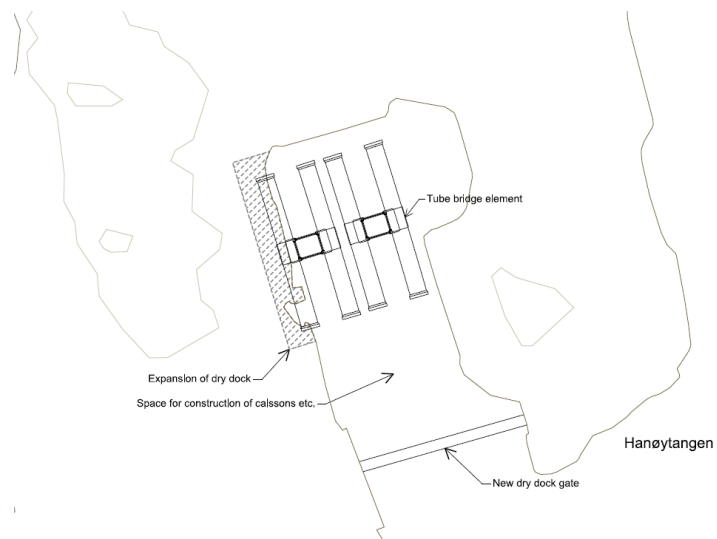


Map 2: feasibility studies

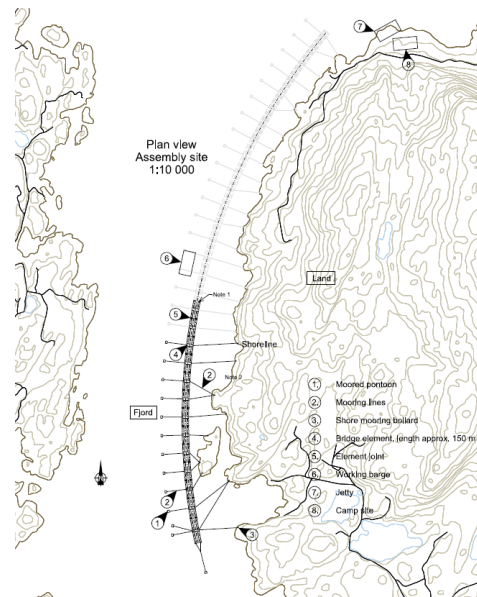




A huge possibility



SFTB: construction in dry docks – Statens vegvesen



SFTB: assembly phase – Statens vegvesen



Towing phase for offshore structure



Statens vegvesen

When?



Thank you
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SFTB for crossing the Sognefjord – Statens vegvesen

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