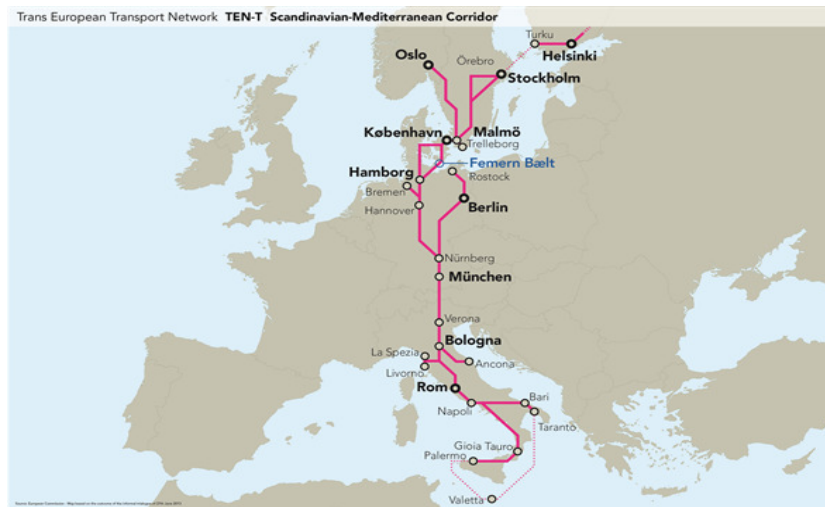


Fehmarnbelt Tunnel Project

Project Location

The Fehmarnbelt tunnel is a new to build (start 2017) fixed link between Scandinavia (Denmark) and Germany.

The tunnel will be situated in the Baltic Sea and is part the 'Scandinavian – Mediterranean' TEN-T corridor

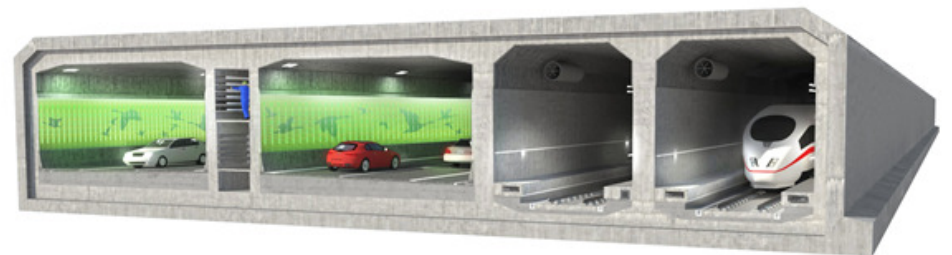


Type of tunnel

With a length of +/- 18km it will be the longest combined rail and road tunnel in the world, to date.

A feasibility study in 1999 gave 4 different alternatives: 2 bridges and 2 tunnels (bored + immersed). The immersed tunnel was chosen

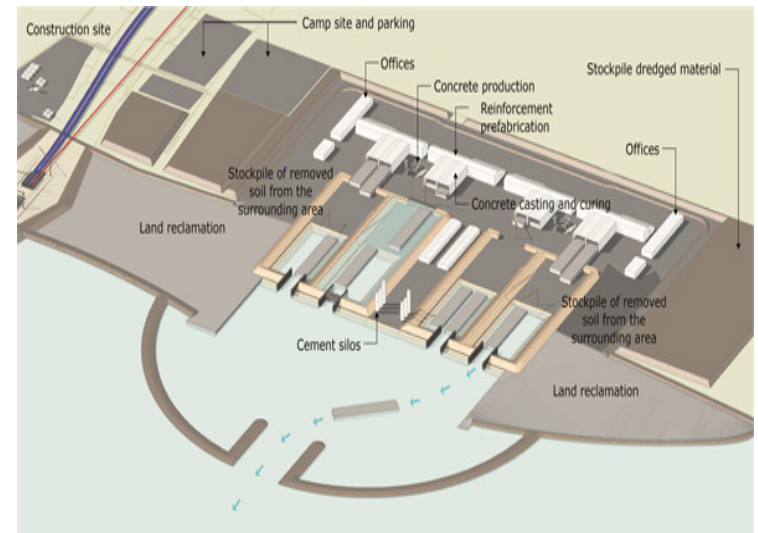
The tunnel consists of 2 road tubes, a central gallery and 2 train tubes; allowing train passage up to 200km/h



Production of the tunnel

The tunnel elements will be produced in a large purpose-built factory east of Rødbyhavn (Denmark). The factory will have 8 production lines and 'each' line will cast 1 tunnel element of 217m every week.

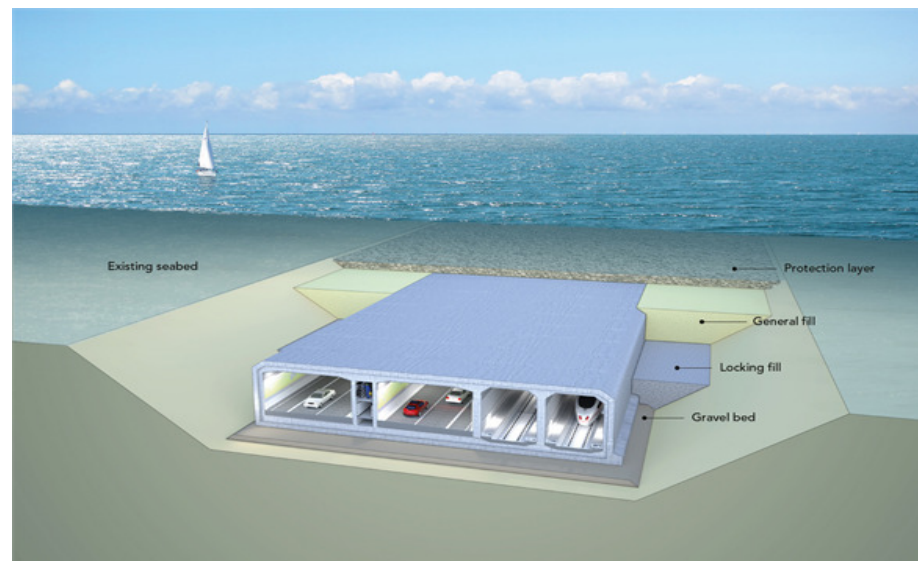
Tug boats will transport the tunnel elements out of the dock to the tunnel trench where it will be immersed and installed



2 different types of elements

Standard elements

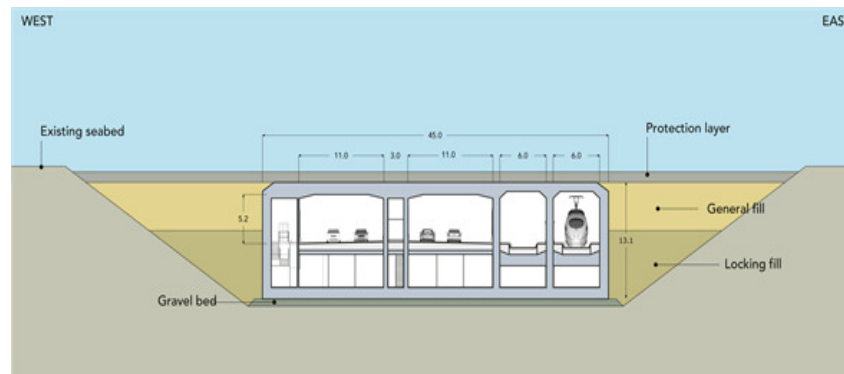
- Dimension: 217m x 42m x 9m
- Weight: +/- 77.000 tons
- Number: 79, each consisting of 9 tunnel segments



2 different types of elements

Special elements:

- Dimensions: 35m long x 45m wide x 13m high
- Number: 10, divided over the length of the tunnel
- Special: 'basement' under road and railway track
 - Electrical equipment
 - Mechanical equipment
 - Safe havens
 - ...



General safety concept

General concept:

Driving through the tunnel must be at least as safe as driving on an open motorway

3 safety priorities:

- Accidents must be prevented
- Consequences of accidents and emergency situations must be minimized
 - Containment of incidents (fire)
 - Self rescue to safe havens
- Ensure rescue services to do their work with the highest degree of safety

Fire safety

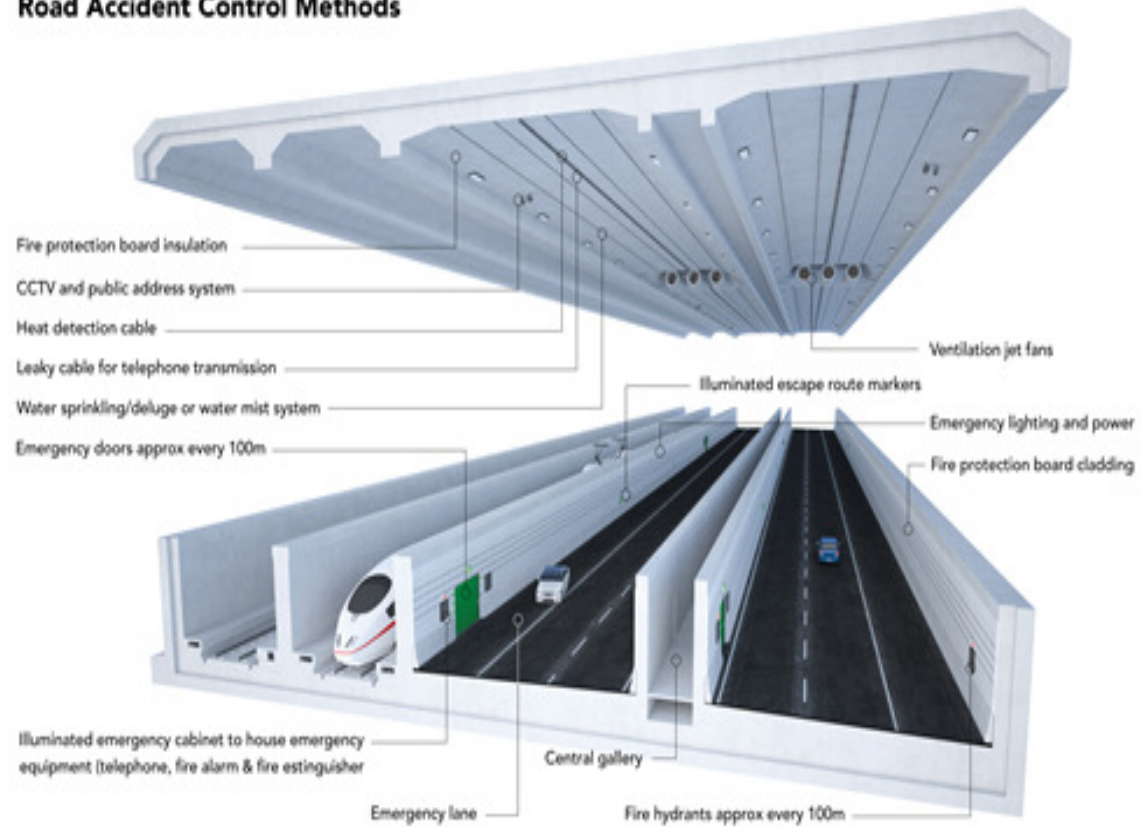
Should a fire occur, it is important to contain it from spreading or endangering other tunnel users.

A combination of systems will:

- Protect all critical structures (ceiling 'AND' walls) against fire
- Prevent fire spreading to nearby vehicles
- Control the smoke
- Stop incoming traffic
- Provide who needs it every 100m safety with equipment

Fire safety

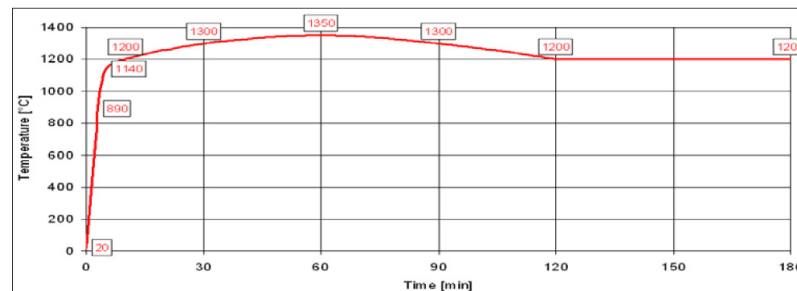
Road Accident Control Methods



Requirements fire protection

Fire resistance for ceilings and walls

- Fire load curve: 180 min RWS for ceiling, tunnel walls and water barriers (joints)
- Max temp interface:: 380 °C
- Max temp rebar: 250 °C
- No spalling of concrete is allowed
- Max temperature on sealants may not exceed maximum operational temperature



Requirements fire protection

Dynamic loadings:

- Road tunnel: + 3kN/m² or – 3kN/m²
- Train tunnel: +4kN/m² and – 2kN/m²
 - 15.000 cycles/y

Design life: 120y is asked in general

Other requirements:

- Mechanical fixation obliged
- Frost – Thaw resistance
- No toxic gasses shall be released during fire
- Fire reaction: A1 according EN13501

Requirements fire protection

Extra !!

Vertical lining road tunnel has to fulfill all previous requirements

- + decorative light reflection finishing
- + some areas have video walls
- + must be cleanable with brushes
- + easy to replace
- + impact resistance
- + ...



Conclusion

- 180 minutes RWS
- Severe dynamic loadings
- No release of toxic gasses allowed during fire
- +/- 1,5milj/m² to be delivered in 20 months
- ...

The Fehmarnbelt Tunnel project challenges all PFP manufacturers to improve their systems and sets new standards in fire protection of tunnels.

→ Is Promat ready? YES !!

Questions



**BENELUX
CHAPTER**

Pictures with the courtesy of Femern A/S