

Project identification

Fehmarnbelt Fixed Link project - Development of the World's Longest Immersed Tunnel

Type of project

Transportation Infrastructure; Immersed tunnel



Client

Femern A/S

In co-operation with

Ramboll and Arup

Project assignment

(1) Conceptual Design; (2) Plan Approval Design; (3) Illustrative Design; (4) Preparation of Tender documents; (5) Cost Estimations; (6) Competitive Dialogue; (7) Review of Detailed Design; (8) Construction Quality Supervision

Country

Denmark

Location

Copenhagen

Project duration

2009 - 2021

Project phase

Construction Tendering Phase (2015)

Construction cost

Appr. Euro 4 billion

Consultancy fee

Appr. EUR 15 million (TEC share until mid 2015) (excl. VAT)

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Project description

The Fehmarnbelt Fixed Link is a permanent and direct road and rail connection between Scandinavia and continental Europe crossing the 20 kilometre wide waters of the Fehmarnbelt and is expected to bring economic benefits to the entire region around the Fehmarnbelt.

The Link will run from Rødbyhavn in Denmark to Puttgarden in Germany next to the existing ferry connection. The opening of the Fehmarnbelt Fixed Link will reduce travel time with 30 minutes eliminating the time spent on embarking, disembarking and waiting for ferries. The rail connection is part of the European TEN rail network and will reduce the travel distance with some 120 kilometre.

The project was already initiated in 1991 as part of the Treaty between Denmark and Sweden to construct the fixed connection crossing the Oresund between Copenhagen and Malmö. A further treaty between Denmark and Germany was signed in 2008 providing the green light for realization. After the initial feasibility studies two options remained (either a full bridge or tunnel solution) and in 2009 a design competition was undertaken to support the final decision.

These competitive designs were undertaken by separate design groups commissioned by the state owned Owner's organization Femern A/S, established to plan, finance and realize the Link. The bridge design and tunnel design were prepared in strict isolation for detailed comparison on safety, construction and life time costs, construction and operational risks, and environmental impacts. In 2011 the (immersed) tunnel design was selected as the best option for this Link considering the about equal life time costs and a better performance on risks and environment as compared to the bridge design.

The tunnel design team was commissioned to further detail the design and to start the applications for the Danish and German Plan Approvals, and further to start prepare the procurement for realization.

The construction of the fixed link, which measures some 25km in length, has been packaged into 6 contracts; 4 contracts for the main civil works and 2 contracts for the installation of the electro-mechanical and rail systems respectively. The main civil contracts are: (1) Tunnel North; (2) Tunnel South; (3) Tunnel Portal and Ramps; and (4) Dredging and Reclamation.

Prequalification for the construction tenders commenced October 2012 and 12 consortia were selected to bid on the four main civil contracts in May 2013. The tendering process is according the Competitive Dialogue procedure, which is a fairly new procedure for the procurement of complex public works in Europe allowing for intensive dialogue between the Owner and the Consortia to clarify requirements and avoid misunderstandings prior to submission of the best and final offers. This tendering process is still ongoing and is expected to be concluded by the end of 2015.

The Link will consist of a two-lane dual highway plus an emergency lane, and a dual railway with a 120 year design life. The tunnel will be a segmented concrete tunnel founded on a gravel bed comprising 80 elements with a length of about 217 meters. The tunnel will be approximately 40m below the seabed and during its life time some 100,000 ships will pass over it and for that reason covered with a stone protection layer.

The tunnel portals on both sides are partly constructed on reclaimed land from materials dredged from the tunnel trench. The reclamations further provide space for landscaped nature and recreational beaches.

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Scope of work

The immersed tunnel design team comprises a joint venture between Ramboll, Arup and TEC and after the design competition was commissioned they deliver the design, approval, procurement and supervision services. The main scope of work is to develop and realize a state-of-the-art immersed tunnel, which is sound and robust with respect to construction as well as operation and maintenance for a period of 120 years, backed up by solid cost estimates and technical and aesthetical evaluations.

Since 2009 these Tunnel Design services included:

1. Competition Design
2. Concept Design for Permanent and Temporary Works
3. Plan Approval Design
4. Illustrative Design for Tendering
5. Construction Packaging and Interfaces
6. German Plan Approval Documents
7. Danish Plan Approval Documents
8. Cost Estimations and Risk Assessments
9. Architectural Design of Portals and Buildings
10. Landscape Design of Land Reclamations
11. Assistance with Prequalification and Evaluation
12. Technical Tender Documents
13. Technical Bid Evaluation
14. Assistance during Competitive Dialogue

The services are commissioned to continue with:

15. Review of Basic and Detailed Design prepared by the Contractors
16. Construction Quality and Site Supervision
17. Commissioning Services.

Some of the key issues of the Fehmarnbelt tunnel included (i) the safety and ventilation concept of the World record longest immersed tunnel (ii) the development of standard and special tunnel elements to optimize a further industrialization of tunnel construction by concentrating the main installations in these deeper special elements and saving space in the standard elements (iii) the development of a common design basis for approval in both Denmark and Germany with – in spite of the Euro codes - distinct different approaches towards construction safety; (iv) the settlement behaviour and foundation concepts of the immersed and cut & cover tunnel over “swelling” clay formations and newly reclaimed land; (v) the design of the tunnel trench including dredging of hard glacial materials and strict requirements for spill reduction; (vi) construction packaging and scheduling of 6 parallel contracts with some 150 interfaces and including intensive parallel works for immersion, ballasting, and interior finishing from two sides; (vii) the navigational restrictions and safety considerations for off-shore works; (viii) the logistics on site and element production facilities for both standard and special elements.