

Project identification

Limfjord tunnel, Aalborg, Denmark

Type of project

Assessment of an existing tunnel



Client

Danish Road Directorate

In co-operation with

COWI, BAM, Ramboll, Christiansen & Essenbæk, Atkins and nmGeo

Project assignment

Assessment of an existing Immersed Tunnel

Country

Denmark

Location

Aalborg

Project duration

2018-2019

Project phase

assessment and retrofit of existing structures

Construction cost

n.a.
(excl. VAT)

Consultancy fee

approx. € 160.000
(excl. VAT)

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Limfjord tunnel, Aalborg, Denmark

Assessment of an existing Immersed Tunnel

Project description

The existing tunnel link between Aalborg and Nørresundby is a highway tunnel crossing below Limfjorden. The immersed tunnel is a monolithic reinforced concrete structure that was constructed during the late sixties. From the very beginning the tunnel is suffering leakages especially in the middle section of the tunnel. Several (major) repair campaigns have been undertaken but did not provide the ultimate solution of stopping the leakages. Annual injection campaigns remain needed to manage the leakage issue. From a durability point of view this has becoming more and more a concern for the Owner. Additionally, continued settlements are observed since 1969, in the northern section of the immersed tunnel reaching as much as 130 mm, which can be considered as substantial. This has given another reason for concern for the Danish Road Directorate. To clarify the remaining lifetime of the tunnel, the Danish Road Directorate has established a geotechnical and structural expert group, to further analyse both the above issues.

The geotechnical expert group acted in the period of May 2017 to April 2018 under the mandate of identifying the reasons for the observed settlements and predicting additional settlements until 2070. The structural expert group worked in the period of May 2018 to June 2019 using the results of the geotechnical working group:

- Extensive condition assessment, from a structural and material degradation perspective
- Describe a long-term maintenance plan and outline one or more repair project(s) including impact for the availability of the tunnel.

The structural working group consisted of experts in the field of immersed tunnelling, structural and geotechnical engineering and concrete repair strategies. The working group carried out detailed condition assessments and defined scope packages for further detailing by assigned project teams. The following studies were undertaken:

1. Structural condition assessment in both transverse and longitudinal direction and verification in accordance with the Eurocodes or more state-of-the-art design codes. This included the definition of, the assessment of and verification against future settlement scenarios subjected to the tunnel structure.
2. Comprehensive physical condition assessment of the tunnel structure (destructive and non-destructive testing material, chemical content, chloride and water content, HCP measurements). The working group defined the testing scope and interpreted the test results.
3. Assessment of the tunnel joints.
4. Development of Basic Maintenance and Repair Strategy; basically a "business as usual" -strategy supplemented by additional activities recommended by the Expert Group.
5. Retrofitting Projects; the remedial actions include geotechnical and structural retrofitting projects.
6. Development of a set of criteria to monitor the tunnel behaviour in the next 50 years with threshold levels for the implementation of retrofitting projects.

The overall conclusion of the extensive condition assessment by the working group is that it is considered very unlikely that the tunnel will exceed safety requirements in the next 50 years. The Basic Maintenance and Repair Strategy combined with a monitoring plan and back-up retrofitting plans to be implemented in the unlikely case of sudden decrease of the tunnel condition, was considered a viable Operation and Maintenance strategy.

Scope of work

TEC participated in the structural working group and undertook tasks such as structural assessment in transverse direction, the development of an advanced nonlinear FE model and verification against state-of-the-art design codes and in-depth reviews of documents prepared under the supervision of the expert group.