Refurbishment and lifetime assessment of the Beverentunnel in Liefkenshoek

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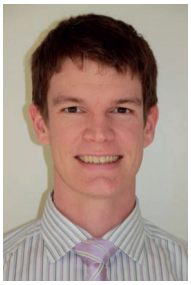

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Summary

The Liefkenshoek Railway Link is a new railway line for freight transportation in the port of Anwerp. Along with two new 6,1km long bored single-track tunnels Infrabel incorporated the Beverentunnel in the new railroad track, a 38 year old reinforced concrete tunnel crossing the Waasland dock on the left bank of the river Scheldt. The 1200m long tunnel was built in open trench before the dock was excavated. A test program was set up to gather information and to determine the remaining lifetime. As results were positive the tunnel will be taken into service after a structural refurbishment. Assessing a structures lifetime becomes even more important as DBFM-contracts arise frequently.

Keywords: durability, refurbishment, tunnel, lifetime assessment, Liefkenshoek Railway Link

1. Introduction

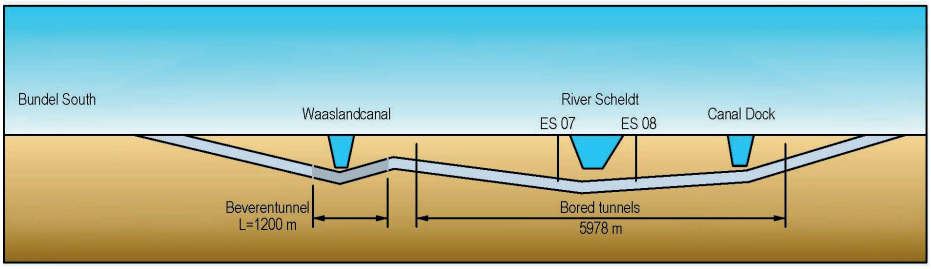

Fig. 1: The Liefkenshoek railway link

The Liefkenshoek Railway Link consists of a new railway line for freight transportation linking the left and right bank of the river Scheldt in the port of Antwerp. The project is a public private partnership. The river Scheldt and the canal dock are passed with two bored single-track tunnels. The Waasland canal is crossed using the Beverentunnel.

2. History

The Beverentunnel was built back in 1974. The tunnel consists of 67, 18m long, elements. In between two elements a rubber joint with vulcanised steel plates was used. The short segments assured the longitudinal flexibility of the tunnel chain. This was important since a heave of 250mm was to be expected due to decompression of Boom clay underneath the dock. To improve water tightness a protective layer encapsulates the tunnel.
The tunnel was constructed in two phases to speed up availability of the new portal dock.

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3. Structural Refurbishment

3.1 Test program

As the tunnel is 38 years old, the contractor had to make an assessment of its present condition, set up a refurbishment and estimate the remaining lifetime of the tunnel in order to establish an effective maintenance program.
The tunnel has been inundated during one year. The brackish water caused an elevated chloride percentage near the surface. However, concrete cover ranges from 60 till 90mm and test results show no particular threat to the service life of the structure. Chloride attack will only continue from outside of the tunnel were little oxygen is available to sustain the corrosion process. Although maximum measured carbonation depth of 20mm may be too optimistic, since the tunnel was a sealed construction for 38 year, worst case calculations results in at least 200 year lifetime.

3.2 Refurbishment program

To mitigate the heavily corroded zone on the lower part of the walls a new shotcreted wall was placed in front of it.

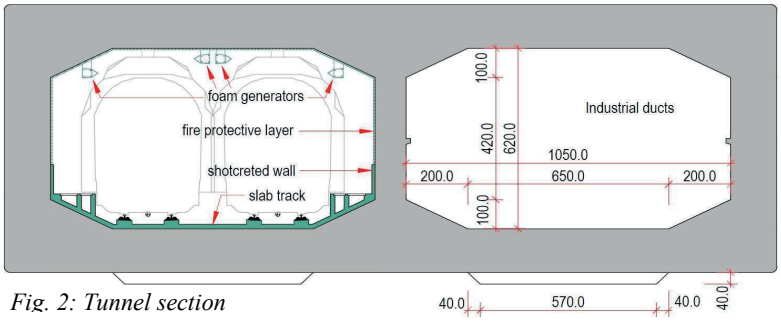

Fig. 2: Tunnel section

The bottom of the tunnel was covered with a slab track. This slab is properly joined to the tunnelfloor by chemical anchors and will prohibit all external influences to the tunnelfloor.
To provide a two hour resistance to a RWS tunnel fire, a fire protective layer was sprayed on the remaining walls and ceiling. Although the initially demanded concrete strength was only 35MPa, values up to 67MPa were measured. In situ tests indicated thickness of the protective layer needed to be increased to avoid spalling. In addition to this passive fire resistance an Active Fire Fighting System is installed in both the bored and the Beverentunnel. In case of fire detection, this system floods the affected 60m zone and its neighbouring zones with high expansion air inside foam. Within 3 minutes the total tunnelsection is filled and fire will be extinguished.

4. Conclusion

At present sufficient knowledge is available to design a new structure in order to achieve a specified durability. When it comes to judging an existing structure things get difficult.
Part of the structure might be inaccessible for inspection and repair. Basic information about the structure isn't available anymore and important parameters needed for calculation models are to be measured on young concrete. Much information on the environment is obscured and important calamities are not reported well. There might also be important changes in the boundary conditions and it is not yet possible to include all beneficial impacts.
Although test programs can assure structural stability, predicting future maintenance needs is difficult but important since more contracts are Design Build Finance and Maintain.

5. References

[1] VERMEER M. and BREUNESE A., "Mobile furnace for determining fire resistance of existing concrete tunnel linings", *ISTSS*