

Report of European workshop at Copenhagen (September 6, 2022)

Monitoring and data collection for improving asset management tunnels

The Netherlands knowledge centre for underground construction and underground space (COB) organized a workshop during the World Tunnel Congress 2022 in Copenhagen. This workshop on ‘Monitoring and data collection of immersed tunnels’ took place on the 6th of September at the Danish Road Directorate (DRD). The workshop was organised together with different partner organisations such as the Danish Vejdirektoratet and Sund und Baelt, the Flemish Agentschap Wegen en Verkeer, the Dutch Rijkswaterstaat and Engineering Society KIVI and the European Conference of European Directors of Roads (CEDR). In addition to the Dutch, Flemish and Danish people, people from other countries such as Norway and Australia also participated.

The main goal of the workshop was to explore how the monitoring strategy, which the COB has developed to monitor older immersed tunnels in The Netherlands, can be transformed into knowledge internationally useable for newly built or not yet built tunnels such as the Fehmarnbelt tunnel.

The workshop started after a plenary reception. Mr. Jens Holmboe of the Vejdirektoratet and Mrs. Karin de Haas of the COB welcomed the participants and gave a short introduction on the programme. This was followed by short lectures by Mrs. Brenda Berkhout and Mr. Bart Duijvestijn from the COB and Kim Smedegaard Andersen from Fehmarnbelt tunnel/Sund & Bælt.

Monitoring strategy

Berkhout explained the new developed monitoring strategy for immersed tunnels, which for the time being focuses on the deformation of the tunnel structures and the tunnel joints. The idea of this strategy is to collect data in the same, consistent way at three road and two railway tunnels in the Netherlands. This makes it possible to compare data of multiple tunnels. With this data researchers hope to increase their knowledge of the condition and deformation behaviour of tunnels and the different failure mechanisms that nowadays are still considered ‘black boxes’. Examples are seasonal and tidal effects, the effects of traffic loads, the behaviour of the sand bed foundation and the deformation capacity of the (immersion) joints, collars and share keys.

For the research of these failure mechanisms it would be helpful if data becomes available from as much different tunnels as possible. Therefore the COB asks partner organisations abroad to share monitoring data. If there is more insight in the failure mechanisms, then the monitoring strategy can be improved, which will contribute to a better asset management, more predictable maintenance and a better estimation of the residual life of tunnels.

New data retaining and knowledge system

In his talk, Duijvestijn proposed the development of a new system for retaining data and knowledge about tunnels. The aim of this system is to secure, unlock and enrich data about the civil, technical and geotechnical aspects of existing tunnels, now and in the future. Relevant domains of the knowledge system are tunnel components, maintenance plans, outcomes of investigations and measurements on assets and knowledge from other projects, and failure mechanisms. The idea is to connect the knowledge system directly to the core data systems of the tunnel administrators. The data collection at the five Dutch tunnels is the start of storing content in the knowledge system.

Duijvestijn assumes the data can be used for different goals, like ‘dash-boarding’, scientific research and optimizing measures.

Monitoring Femernbelttunnel

Smedegaard Andersen explained the planned monitoring of the Femern Immersed Tunnel. This monitoring consists of three different monitoring systems, namely a system for sensing and monitoring the daily operation, a system for monitoring the tunnel structure itself and a system for monitoring corrosion.

The ‘structural’ monitoring already starts during the construction of the tunnel to meet the assumed construction tolerances. For example, the foundation bed will be monitored during the immersion to avoid overstress of the tunnel elements. The immersion and segment joints will also be monitored to assure the water tightness of these joints.

Naturally the tunnel behaviour will also be monitored after the immersion, because this is the way to assure the clearance gauge for railway and road for 120 years, safe railway operation and the water tightness of the immersion and segment joints. Furthermore, the monitoring must guarantee not to overstress the tunnel elements by heave or settlements, and contribute to understanding the annual joint movements.

Interesting measurements

After these interesting lectures the group split up to discuss and share knowledge during two parallel breakout sessions. In the first session ideas were exchanged about monitoring of existing and newly built tunnels. The participants discussed the COB’s strategy for existing tunnels, how monitoring of newly built tunnels should differ from existing tunnels and what other parameters should be monitored at newly built tunnels. During the lively discussions a lot of ideas were exchanged. It was stated that the monitoring scheme for existing and newly constructed tunnels should be consistent to make data comparable. It is also important that the data collected during construction and operation are consistent and comparable. Furthermore, administrators should take care that monitoring systems are maintained and, if necessary, adjusted after a renovation. It is important for all monitoring projects to identify the nice-to-knows and the-need-to-knows.

At the Fehmarnbelt tunnel the collection and storage of monitoring data will already start during the construction phase. These specific monitoring data are important because with existing tunnels this data is usually not preserved, while they are crucial to understand the failure mechanisms. Several interesting measurements are planned: for example, some concrete test pieces will be hung up in the salty seawater of a harbour near the tunnel entrance, made of the same concrete as the tunnel elements. This way, the deterioration of the concrete on the outside of the tunnel can easily be monitored by regular lifting the test pieces. Furthermore, the sedimentation on top of the tunnel will be closely monitored to avoid overloading.

One of the discussions was about whether a long tunnel like the Fehmarnbelt with an overall length of 18 kilometres behaves differently and should also be monitored differently than short tunnels. Most participants think length doesn’t really matter. A promising option for monitoring long tunnels would be the use of fibre optic cables.

Joint data base

In the second session it was discussed if it is worthwhile to investigate the idea of developing a new, widely usable data retaining and knowledge system for tunnels . Furthermore, the participants discussed how a long term monitoring system, which could improve the asset management strategy and asset management organisation, can be implemented and be financed.

Most participants agree that a joint data base and a smart wiki page for questions about tunnels are good ideas, because parties can learn from each other. They agree also that it is useful to have data from as many different tunnels as possible. There is however a discussion about the ownership of data and the question for whom the data are accessible. And although parties see the value of international cooperation, for example in the field of research, they still seem somewhat apprehensive about such cooperation. A recent development is that road and rail administrators such as the Dutch Rijkswaterstaat and ProRail consider it important to become the owner of monitoring data themselves so that they can extract information from this data themselves.

To realise a useful data base, it is important to establish criteria and guidelines for the monitoring data together: what should be monitored, what is necessary and which quality requirements must the data meet?

Good start

The meeting was concluded with a plenary part, where the results of the two sub-sessions were shared. According to Karin de Haas, director of the COB, and Jens Holmboe of the Vejdirektoratet the meeting was a good start of international cooperation in the field of monitoring, asset management en refurbishment of tunnels.