Nederlands kenniscentrum voor ondergronds bouwen en ondergronds ruimtegebruik

CSI for tunnels, never unpredictable maintenance

Let's talk, discuss and improve. Please contact us at www.cob.nl, karin.dehaas@cob.nl or 0031 6 5429 1940

Worldwide, renovation of tunnels is becoming a huge challenge. Due to the large costs and the need for accessible infrastructure, choices need to be made as to which tunnels will be renovated first, which renovations can be postponed and what should be the scope. Unfortunately, we lack the knowledge to develop a proper asset management strategy for tunnels. With a position paper the Dutch COB aims to form an international group of experts to discuss, develop and work on this challenge. As a preliminary conclusion we found seven areas on which we want to focus. As an opening for discussion we would like to state that, based on all above, the following 7 topics are blank spaces in our puzzle:

1. Effect on the tunnel as a system

We do have fundamental knowledge and practical insight on most aspects of the tunnel but we have very little insight in the effect of all those loose aspects on the tunnel as a system (within a traffic system and within the surroundings and as a stand-alone object).

Structures shall be designed, constructed and maintained in such a way that they perform adequately and in an economically reasonable way during construction, service life and dismantlement. In this context, structures are perceived as an arrangement of interacting structural components, all together providing a solution to meeting performance requirements under a specified combination of (direct and indirect) actions. This implies that performance of a structure is a system problem and should therefore be treated taking into account structural system characteristics. This consideration is generic, hence it holds true for all performance aspects related to safety, serviceability and durability.

In the context of performance-based approach, durability refers to the fulfilment of the performance requirements during specified period of time and within the framework of the planned use and foreseen actions, without unforeseen expenditure on maintenance and repair. Considering the abovementioned system aspect of performance assessment, durability of a structure shouldl be understood as durability of a structural system composed of a number of components, adequately taking into account that a single component may also be prone to several failure modes of various importance. Therefore, the likelihood of durability loss (i.e. reaching the end of the required service life) should be assessed considering complexity of the structural system, taking into account both (1) the susceptibility of the individual components to (a number of) possible degradation mechanisms and associated failure modes and (2) the robustness of the structural system in respect to avoiding disproportional damage of a larger part of the structure. Note that the problem grows with the system size (number of system components) and degradation complexity: it shouldbe considered that system component s may interact while degradations may be related, possibly interacting or triggering each other.

2. Difference in insights then and now

The people who are responsible for the asset management of tunnels now look at those objects with the knowledge we have now. The effect of difference in insight (why was the tunnel built as it was built) and what kind of tunnel do we have now? This is a large concern but also a big chance. Looking at the tunnel now from knowledge of the past can help us make better predictions of failure mechanisms in the future.

3. Reality versus drawings

We know that almost every tunnel is not built as it was designed. Also there is very little as built-information available and often there is no well documented archive of every intervention in or around the tunnel. The basic information about the state of the soil/surroundings before the tunnel was built is also often missing. And last but not least sometimes faults are being made by constructors during building. So what do we know about our constructions, what do we own? It would be of great use to come up with a strategy to find this missing information in a way that is not only useful for an individual tunnel owner, but to get a better insight in over-object-problems and solutions.

4. What is safe?

Everything stated at 1, 2 en 3 has an influence on the aspect safety. What is safe ? What do we do when an object is not sufficient safe anymore to the current standards but isn't failing as a system? Do we know when failure occurs and how to define that risk both in investment as in consequence?

5. Does it help? Is there help?

If we have a fault tree of all the relevant failure mechanisms we hope to have options to repair. What we don't know is if these repair options really help in the long term. We also expect to find failure mechanisms without real solutions. And how to deal with the parts of the tunnel that cannot easily be reached, such as the foundation? What's the plan B?

6. Can we quantify the residual life?

If a renovation is worth the investment has a lot to do with the true life expectancy of the construction. The Maastunnel, the oldest tunnel in the Netherlands, is currently renovated for 262 million euro's. Is this a good investment ? Will we still say yes if in 50 years the construction is really failing?

7. Relationships and effects

We see that geology, climate change, different usage, pressure changes etc. all have effects but we know too little about the interaction and the effect on failure mechanism. We have interesting monitoring systems but little insight in the information behind the data and the smart way to implement a monitoring system.