Abstract

Since the mid 1970s, road tunnels in Germany are primarily being planned and constructed in order to improve unfavorable or unsafe routes. Tunnels are characterized by both, high specific construction costs as well as comparatively high expenditures for the operation of the facility. Especially those costs occurring in the operational phase are usually only based on a rough estimate.

A restrictive financial budgeting of the public sector requires today more than in former times to plan investments thoroughly. The life-cycle concept enables to apply a sustainable cost planning scheme. Within the scope of this research work, the life-cycle concept is being adapted to the particular properties of tunnels. At the same time the focus is directed on identifying the most economic solution among a list of feasible technical alternatives. This process merges the construction and the operational phase in order to consider it as one unit. In this way all necessary prerequisites have been established in order to examine different alternatives by substituting follow-up by initial costs and vice versa.

In terms of a life-cycle approach the designer or operator needs to be familiar with useful lives and costs of all structural parts and components in a tunnel. In addition to all expenditures for the initial installation, further indicators are required according to maintenance, energy consumption as well as concerning useful lives of components.

The motivation for this scientific work is based on the development of a systematic approach for the calculation and analysis of the life-cycle costs for road tunnels. Therefore, all costs associated with materials and technical components have to be assigned to their appropriate time of occurrence. The investigations cover two basic cases of application: The first case refers to the phase of a new tunnel design, whereas the second case aims to reconstruct the life-cycle costs of a tunnel in operation, which is followed by the extrapolation. Beside the adaptation of economic approaches into the planning and operational phase of tunnels, a statistical analysis, which is based on a recorded failure history, allows to predict the failure behavior of parts and components. The data obtained will on one side help to increase the accuracy of the life-cycle cost prediction and on the other side to close an information gap which currently exists in design guidelines. In addition, an approach is being derived how to conclusively limit and deal with uncertainties resulting from costs. Each cost increment to be introduced into the tool might be expressed as an interval, mirroring its specific grade of uncertainty. As a consequence, the calculation results are also given in terms of a spectrum. Along with the calculation of the life-cycle costs for the entire tunnel structure, a component-specific cost index expresses the time-dependant development of follow-up costs in relation to the initial costs.

The approach described above has been utilized to develop a software-based tool. In summary, planners and operators of road tunnels are given a method to analyze the profitability of future projects and to check follow-up costs of existing tunnels in order to check as well as to increase the efficiency on a long term basis.