Zukunft Bau

SHORT REPORT

Integrated Life Cycle Optimization (ILCO)

Methods for systematic exploration of variants in early stages of planning with special focus on life cycle aspects

Background & Goal

When planning life-cycle-optimised buildings, various influencing factors must be carefully attuned. Between these factors, however, numerous dependencies exist, making a manual procedure for optimization difficult and time-consuming. In this project, methods were developed that enable planners to systematically and efficiently search for life-cycle-optimized buildings.

Summary

Life cycle approaches are becoming increasingly important in the planning and construction of buildings. The life cycle performance, describes the sum of all expenses for the construction, operation and demolition or demolition of a building in relation to the use and lifetime of the building. In order to maximise the life cycle performance of a building for a certain lifetime, the sum of all expenses must be minimised and the benefit of the building maximised. To achieve this goal, it is necessary to integrate life cycle considerations into the planning process as early as possible, because decisions taken in the so-called early planning phases have the greatest effects on the quality, costs, energy requirements and environmental impact of a building.
When planning a building, various influencing factors (geometry, material, HVAC) must be attuned carefully. However, there are numerous dependencies between these factors, making a manual optimization difficult and time-consuming. Systematic exploration of the space of possibilities (design space) is therefore often not feasible in real planning processes. Using computer-based methods, a large number of planning variants can be generated and evaluated in relatively short time. So far there are numerous approaches to optimise building designs with the help of these methods with regard to energy criteria. However, only individual influencing factors are considered. In real planning scenarios, an isolated consideration of individual factors is ineffective, as it is often necessary to consider numerous influencing factors simultaneously in order to achieve a holistically good result. However, an automated process for optimizing many influencing factors is only possible to a limited extent when the factors influence each other. The aim of the project therefore was to develop methods that would enable planners to systematically and efficiently search for optimal solutions for life-cycle-oriented buildings. Thereby we focused on the problem that mutually influencing factors cannot be optimized at the same time. To achieve this goal we coupled methods for optimizing individual factors, integrating life cycle analyses and developing a method for multi-stage design exploration.

The focus here was on two areas: firstly, the calculation of the life cycle performance on the basis of the few information available in the

design stage and secondly the exploration of the design space with interdependent design parameters. For the former, a method for estimating LCP in real time based on various life cycle databases and parametric models was developed. For the latter, a framework was developed which allows to systematically compare the generated variants according to various criteria. The functionality of the developed methods was tested in various scenarios. On the one hand, it was shown that the method for LCA calculation delivers valid calculation results very fast. On the other hand, it was shown how different methods for variant exploration can be coupled and multi-stage design spaces can be organized and visualized.

Conclusion & Outlook

With completion of the project, methods are available that are of highest relevance for both architects and researchers. On the one hand, the real-time life cycle analyses and the framework for design space explosion allow to efficiently search for good solutions to design problems. On the other hand, the developed framework provides a new instrument for systematically investigating planning-relevant questions. For example, it is conceivable that research could investigate which design parameters influence the performance of a building/city to which extent and how the order in which design parameters are determined influences this performance. This could lead to insights into which parameters are most effective for achieving certain design goals.