Optioneering of long viaducts via parametric design

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Abstract

During the optioneering phase, engineers face the challenge of choosing between myriads of possible designs, while, simultaneously, several sorts of constraints have to be considered. We show in a case study of a 380 m long viaduct how parametric modelling can facilitate the design process. The main challenge was to satisfy the constraints imposed by several different stakeholders. In order to identify sustainable, aesthetic, economic as well as structurally efficient options, we assessed several key performance indicators in real time. By automatically estimating steel and concrete volumes, a simple, yet suitable approximation of the embodied carbon (considering 85-95%) can be obtained at a very early design stage. In summary, our parametric approach allowed us to consider a wider range of parameters and to react more flexibly to changing conditions during the project.

Keywords: parametric design, optioneering, bridge design, automation, life cycle assessment, sustainability

1 Introduction

The aim of this paper is to highlight the potential of parametric tools to assist engineers during early design stages of long viaducts. By using a parametric approach, we face a philosophical question: Some engineers claim that there are only a handful of input parameters that allow for a systematic approach and point towards realised examples of single- as well as two-span bridges, which were successfully automated. Others, however, think that the multitude of variables with different weighting factors yield myriads of possible permutations that do not allow for an automated one-scheme-fits-all approach, and thus, each bridge constitutes a unique piece of art tailored to the surrounding environment. In contrast to single span bridges, the pier´s positions of long viaducts are interdependent, and thus, a non-trivial optimisation problem arises in which even the boundary conditions are unknown. Standardized, repetitive patterns may have been occasionally used, but rarely lead to ideal solutions for individual cases.

We do not attempt to answer this question and neither do we claim to fully automate the design process – instead, we aim to demonstrate how a parametric workflow may facilitate the design process: by allowing for a change of input parameter in real-time and automating repetitive tasks, amended designs and related results can be visualised instantaneously. This enables designers to consider a broader variety of possible solutions and to explore a wider range of relevant parameters – independently of their design philosophy.

While several software packages exist to support the preliminary design, we prefer to start at a digital drawing board which grants the widest space for creativity. This is not seen as a step in lieu of using established software, but as a complementary step to support the creative process. Hence, the developed *Grasshopper* script is not optimized

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