



# Fast, interactive digital design tools to inform decision making in bridge design

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## Abstract

In light of the climate crisis, it is important to be able to evaluate both embodied and operational carbon quickly and accurately to ensure the best overall decisions are made. This contribution will focus on the use of digital design tools to guide the former, by rapidly identifying the unavoidable embodied carbon associated with the construction of bridges. Practical design tools are introduced in web-app form (LayOpt:BRIDGE) and as a plugin to the Rhino/Grasshopper parametric modelling ecosystem (Peregrine), each giving results in just a few seconds. The speed of these methods facilitates exploration of different sites or materials. The results provide an absolute lower bound on the embodied carbon required, allowing evaluation of the extent to which it is theoretically possible for a given development to be advantageous. Additionally, the benchmark results obtained can be used both qualitatively and quantitatively to inform proposed designs.

**Keywords:** Optimization; Bridge design; Embodied Carbon.

## 1 Introduction

The embodied carbon associated with the construction of bridges and other structures is a particularly hard-to-decarbonise aspect of achieving net-zero in the built environment. In the UK, it has been suggested that reductions of 20% in material usage are required through improvements in structural design efficiency [1], such as using optimized structural forms.

The highest potential for influencing the embodied carbon of a project is at the earliest stages of design, where there is most freedom. As decisions become fixed, the possible level of influence decreases, as illustrated in Figure 1. Thus, it is prudent to focus attention on tools that can be used before an initial concept has been fixed.

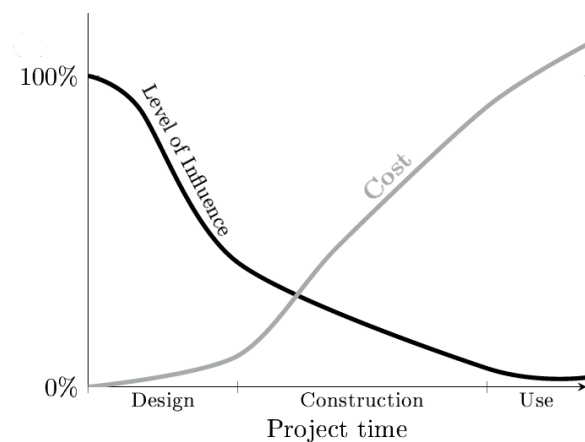


Figure 1 - Changes in the potential level of influence and project costs over time (after [2])