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# Parametric Approach for Composite Bridge Project: analysis and design

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## ABSTRACT

Bridge designs usually exhibit significant geometric variations between different structural solutions, which implies a low degree of reuse of the models in similar projects. To overcome this limitation, a parametric approach is proposed as an answer. Generative design enhances the bridge design process, increasing efficiency by reducing time and effort. The proposed methodology is based on the creation of a flexible geometric model through the introduction of parameters and numerical relationships between them. Therefore, from a generic generative development, different geometric and structural solutions of composite bridges could be created by modifying the parameter values in a bridge model. The objective of the present work is to define the workflow for a multi-girder composite bridge project based on parametric design and optimization in Grasshopper/Rhino to model the bridge Karamba3D, for structural analysis, and Tekla Structures, for 3D representation. This article describes the methodology implemented, starting with the design of the script into a visual programming interface that runs inside Rhino. Thanks to Grasshopper-Tekla live link, the 3D model is generated by using a set of Grasshopper components that can create and interact with objects in Tekla Structures. Afterwards, the algorithm for FEM analysis is created with Karamba3D. Finally, an optimization process is defined to reduce material waste and achieve an efficient design.

**Keywords:** Parametric design, Building information modelling, Optimization, Composite bridges, Bridge Information Modelling.

## 1 INTRODUCTION

Nowadays, architectural design tools have expanded the possibilities for innovative and impressive curves and structural details. Nevertheless, as the infrastructure industry is embracing digitalization to increase productivity and to be updated with new technologies and innovations; there is a framework of increasing costs, sustainability issues, and short deadlines. As a result of these constraints, more and more civil engineers are exploring parametric design and BIM-based workflows. The BIM incorporates all available construction-related data, including architectural design (building element geometry, spatial relationships as connectivity, etc., structural design (project design documentation, structural scheme, and information on the building's construction and maintenance processes (Svoboda et al., 2014. On the other hand, generative modelling enhances the infrastructure design process, increasing efficiency by reducing time and effort. It is based on creating a flexible geometric model by introducing parameters and numerical relationships between them.



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