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Abstract of the PhD thesis:

Modelling and optimization of selected bridges type using BIM environment

Building Information Modelling – BIM – brings together a wide variety of generating, gathering and leveraging building data aspects. In this thesis it has been assumed that a parametric BIM model can be effetely used in a structural optimization process, serving as a database on structure asset as well as the environment of a cost function calculation.

The fundamental aim of the thesis is to determine the scope of actions and activities that are necessary to perform an effective optimization process for a specific type of bridges using a given BIM tool. The tool should enable creation and parametrization of the model and, if combined with optimization algorithms, become a coherent, generative design-based system of structural optimization.

The above-mentioned specific type of bridges is a group of road, slab and girder, post-tensioned structures, including continuous beams. They are a common concept in Polish infrastructure and road projects. Reducing the scope of the analysis to the given type of bridges allows the comparison of a traditionally conducted design process with a fully algorithmic approach.

The essential and the most extensive part of the thesis is the description of the proper extension of BIM environment with the system for evaluation and selection of bridge solution candidates. The system consists of:

- Usage of a predefined BIM bridge model as: a dataset of boundary conditions in the optimization task, a tool for the cost function evaluation and an environment of visualization.
- Modularity of the solution including: 1) the module of BIM geometry processing, 2) the module of static analysis using internally generated FEM models, 3) the module of tendon layout design, 4) the module of reinforced concrete design.
- Merging genetic algorithm and neural networks in order to develop a novel approach as a part of the whole system for optimization of statically indeterminate prestressed structures.

The operation of the developed system was demonstrated in the final part of the thesis. The acquired conclusions and observations can be used as a set of recommendations in the context of bridge BIM modelling and the starting point for creation of similar tools dedicated to other more complex construction systems.

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