Technische Universität Wien
Institut für Mechanik der Werkstoffe und Strukturen

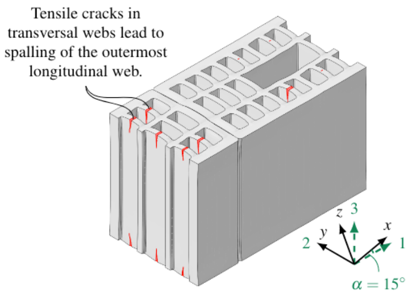
Master's Thesis

Multi-objective optimization of fired clay bricks

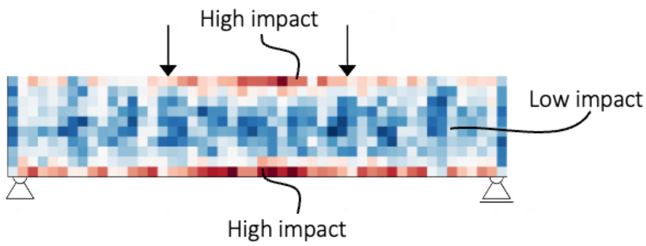
Clay block masonry is widely used in the construction industry due to its durability, fire resistance, low thermal conductivity, large heat capacity, and high acoustic insulation. Besides those factors, it is also well-suited for carrying high structural loads. For masonry to be competitive in the construction industry, adequate computational models are required, allowing a straightforward design process and resource-efficient usage of clay. This drives the development and improvement of finite element models (FEM) for clay block masonry.

One significant advantage of FEM simulations compared to experiments is the possibility of conducting efficient parameter studies and performing comprehensive performance evaluations of designs. In this thesis, a previously developed model for the failure of clay block masonry should be used to optimize the geometry and hole pattern under consideration of thermal conductivity, mass, etc. Initially, the model must be extended to support the automated simulation of parametrized hole patterns. Subsequently, a so-called surrogate model should be developed which bypasses the computationally expensive FEM simulation and allows solving the multi-objective optimization task.

The main challenges of this thesis are the proper formulation of the optimization problem and its multiple objectives (e.g., minimizing the brick's weight) and constraints (e.g., lower bound to compression strength, the maximum size of holes), the development and implementation of a surrogate model (e.g., artificial neural network, polynomial regression models, etc.) and the proper choice of an optimization algorithm.



(a)



(b)

(a) Results of a FEM simulation showing tensile cracks in the bick's webs (b) surrogate model for predicting the maximum deflection of a four-point bending test depending on the spatial variation of longitudinal stiffness

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