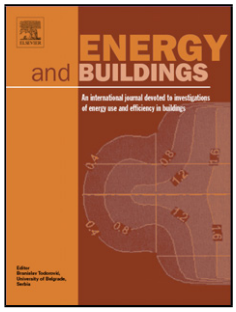

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Multi-objective optimization of a building envelope for thermal performance using Genetic Algorithms and Artificial Neural Network

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Abstract

The objective of this paper is to present a method to optimize the equivalent thermophysical properties of the external walls (thermal conductivity k_{wall} and volumetric specific heat $(\rho c)_{wall}$) of a dwelling in order to improve its thermal efficiency. Classical optimization involves several dynamic yearly thermal simulations, which are commonly quite time consuming. To reduce the computational requirements, we have adopted a methodology that couples an artificial neural network and the genetic algorithm NSGA-II. This optimization technique has been applied to a dwelling for two French climates, Nancy (continental) and Nice (Mediterranean). We have chosen to characterize the energy performance of the dwelling with two criteria, which are the optimization targets: the annual energy consumption Q_{TOT} and the summer comfort degree I_{sum}. First, using a design of experiments, we have quantified and analyzed the impact of the variables k_{wall} and $(\rho c)_{wall}$ on the objectives Q_{TOT} and I_{sum}, depending on the climate. Then, the optimal Pareto fronts obtained from the optimization are presented and analyzed. The optimal solutions are compared to those from mono-objective optimization by using an aggregative method and a constraint problem in GenOpt. The comparison clearly shows the importance of performing multi-objective optimization.

Keywords: multi-objective optimization; building envelope; energy performance; comfort degree; ANN; genetic algorithm

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