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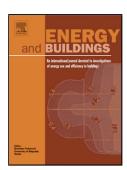
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### ACCEPTED MANUSCRIPT

# 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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