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Multi-Objective Discrete Optimization of External Thermal Insulation Composite Systems in Terms of Thermal and Embodied Energy Performance

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Abstract : These days, increasing global warming effects, limited amount of energy resources, etc., necessitates the awareness that must be present in every profession group. The architecture and construction sectors are responsible for both the embodied and operational energy of the materials. This responsibility has led designers to seek alternative solutions for energy-efficient material selection. The choice of energy-efficient material requires consideration of the entire life cycle, including the building's production, use, and disposal energy. The aim of this study is to investigate the method of material selection of external thermal insulation composite systems (ETICS). Embodied and in-use energy values of material alternatives were used for the evaluation in this study. The operational energy is calculated according to the u-value calculation method defined in the TS 825 (Thermal Insulation Requirements) standard for Turkey, and the embodied energy is calculated based on the manufacturer's Energy Performance Declaration (EPD). ETICS consists of a wall, adhesive, insulation, lining, mechanical, mesh, and exterior finishing materials. In this study, lining, mechanical, and mesh materials were ignored because EPD documents could not be obtained. The material selection problem is designed as a hypothetical volume area (5x5x3m) and defined as a multi-objective discrete optimization problem for external thermal insulation composite systems. Defining the problem as a discrete optimization problem is important in order to choose between materials of various thicknesses and sizes. Since production and use energy values, which are determined as optimization objectives in the study, are often conflicting values, material selection is defined as a multi-objective optimization problem, and it is aimed to obtain many solution alternatives by using Hypervolume (HypE) algorithm. The enrollment process started with 100 individuals and continued for 50 generations. According to the obtained results, it was observed that autoclaved aerated concrete and Ponce block as wall material, glass wool, as insulation material gave better results.

Keywords : embodied energy, multi-objective discrete optimization, performative design, thermal insulation
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