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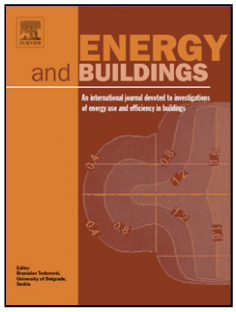

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Lowest thermal transmittance of an external wall under budget, material and thickness restrictions: An Integer Linear Programming approach

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Abstract

This paper deals with the minimization of a building's external wall thermal transmittance, with the aim of improving the energy efficiency of the building. The wall's thermal transmittance must abide by the current legislation, but also suit the limitations of other construction parameters, mainly budget and thickness, but also time limit, workforce, number and thickness of the layers and availability of materials depending on the approach.

The optimization is achieved formulating an Integer Linear Programming (ILP) problem involving the parameters mentioned above. Therefore, any available ILP solver can be run to obtain the best combination of the different materials and thicknesses for the layers, in order to minimize the thermal transmittance. This paper presents a case study of a common but representative external wall consisting of 6 layers, with more than 670,000 possible combinations of materials and their thicknesses. The study concludes with a comparison of the lowest thermal transmittance obtained for a selection of budget and thickness combinations for the mentioned wall.

Keywords

Thermal transmittance; building envelope; external wall; Integer Linear Programming; building process; budget.

1. Introduction

Norms about energy efficiency for buildings in the European Union show an important evolution and development since the approval of the Directive 2010/31/EU [1]. The European Council in March 2010 somehow started the process with a specific action plan for energy efficiency [2] followed by another important and decisive European Council in February 2011. The fact that buildings account for 40% of the EU's energy consumption [3] and the negative effects related with climate changes have increased people's ecological awareness. A growing demand of a more sustainable and healthy indoor environment is described by Liu et al. [4]. Furthermore, the EU has an important triple energy target for 2020: 1) reducing by 20% the produced greenhouse gases, 2) covering at least 20% of energy consumption with renewable energies and 3) improving energy efficiency by reducing the primary energy needs by 20% [5].

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