Accepted Manuscript

Computing the minimum construction cost of a building's external wall taking into account its energy efficiency

Andrea Salandin, David Soler

PII: S0377-0427(18)30074-8
DOI: https://doi.org/10.1016/j.cam.2018.02.003
Reference: CAM 11509

To appear in: *Journal of Computational and Applied Mathematics*

Received date : 1 December 2017
Revised date : 23 January 2018

Please cite this article as: A. Salandin, D. Soler, Computing the minimum construction cost of a building's external wall taking into account its energy efficiency, *Journal of Computational and Applied Mathematics* (2018), https://doi.org/10.1016/j.cam.2018.02.003

Computing the minimum construction cost of a building's external wall taking into account its energy efficiency

Andrea Salandin[a], David Soler[b,*]

[a] *Centro de Tecnologías Físicas, Universitat Politècnica de València, Camí de Vera s/n 46022, València, Spain*
[b] *Instituto Universitario de Matemática Multidisciplinar, Universitat Politècnica de València, Camí de Vera s/n 46022, València, Spain*

Abstract

The construction of a building's external wall is subject to many restrictions such as budget, workforce, availability of materials, thickness, maintenance cost, time limit and specially, energy efficiency legislation intended at mitigating the negative effects of the energy consumption and obtaining a more sustainable and healthier indoor environment. The choice of the appropriate material and thickness composing each layer of an external wall can significantly reduce the energy consumption of the building without adversely affecting the cost of the wall.

By using Integer Linear Programming (ILP), the aim of this paper is to obtain this best choice of materials and thicknesses to minimize the construction cost of an external wall while complying with the abovementioned restrictions. A case study is presented with more than 5.5 million combinations of different selected materials and their thicknesses for the different layers of the wall. The ILP problem has been solved for 165 scenarios that take into account different maximal allowed thermal transmittances and a range of the most usual thicknesses and material options of an external wall.

Keywords

Integer Linear Programming; external wall; building process; budget; thermal transmittance.

1. Introduction

Linear Programming (LP) [1-3] has proven its efficiency to mathematically model many real-world problems aiming at the maximization or minimization of a certain function (objective function) that is linearly dependent on a set of variables related to each other through a set of linear constraints. It is well-known that a LP problem has polynomial complexity when all variables are real and continuous. However, if all variables must be integer (ILP) or it is a mixed case (MILP) where there are both continuous and integer variables, the optimization problem has exponential complexity. In the last two cases, several iterative procedures have been developed to obtain the optimal solution, although, of course, they cannot guarantee that the optimal solution will be found in all the instances within a reasonable time. Sherali and Driscoll [4] provide an interesting discussion of the evolution of the technique and philosophy leading to the current state-of-the-art for modeling and solving ILP problems.

As stated before, many optimization problems in all fields of real life can be modeled as LP problems and the number of applications of LP to real-word problems is

* Corresponding autor, Tel: +34963877007 (Ext. 76667)
E-mail addresses: ansa@upv.es (A. Salandin), dsoler@mat.upv.es (D. Soler).