



# Sustainable restoration of traditional building systems in the historical centre of Sevilla (Spain)

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## ABSTRACT

This study applies eco-efficiency and sustainability criteria to the restoration of a building, as an alternative to strict compliance with planning rules in this field.

The house we have studied dates from the 18th to 19th century and is located in the historical centre of the city of Sevilla, Spain. The main aim is to compare two different restoration plans from an eco-efficiency and sustainability perspective. We also assess the use of recently revived traditional construction systems for this type of building as a means to increase sustainability.

The results from the energy survey carried out in compliance with state building regulations show that a restoration project must be seen as an opportunity to make use of traditional construction systems as a tool for revitalizing and conserving historical city centres, and for promoting a new building model with sustainability as the centrepiece of architectural restoration.

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## 1. Introduction

The idea behind “sustainable construction” is to minimize energy costs in the construction and maintenance of buildings. In its lifetime, a building will consume between 20 and 50% of the physical resources in its environment [1]. This fact, together with today's ecological pressures, requires a new approach to building, such that government agencies are moving rapidly to impose new mandatory standards [2] on energy efficiency for both new buildings and those under restoration.

Energy consumption is quantified as the energy used in the construction of the building and the maintenance required during the useful life of that edifice [3]. Energy saving in construction consists of:

- Reducing energy consumption during maintenance, by means of improving the insulation system of the building's envelope, which in turn will also cut cooling and heating costs.
- Reducing energy consumption during construction by using materials with a low-energy cost, such as recycled or recyclable materials, to guarantee the sustainability of the building.

Various authors have studied the effects of replacing certain materials with energy-sustainable materials in construction.

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Scheuer et al. [4] analysed the steel beams used for the roof at Oslo Airport and concluded that the energy cost for their construction was twice or three times higher than that for laminated timber beams, with fuel consumption 6–12 times higher. Buchanan [5] suggested that an increase in the use of wood as construction material could have a positive effect on global energy demand and the reduction of CO<sub>2</sub> emissions. Other research involving buildings in The Netherlands [6] show that greater use of wood in building construction could cut CO<sub>2</sub> emissions by 50% compared to traditional building materials.

The use of recycled or recyclable materials is a relatively new concept that aims to cut down on energy costs and maintain a building's energy balance in the long term. A Japanese study by Gao et al. [7] of energy saving in the construction phase of three buildings showed that energy consumption dropped by 25% when recycled materials were used. A similar study by Swedish investigators [8] modelled the construction of a house made almost exclusively with recycled materials against a similar residence built entirely with new materials. The results showed a 40% energy saving.

## 2. Objectives

This paper compares two restoration projects for a residential building in the historical city centre of Sevilla (Spain). Firstly, we analyse the developer's project, which follows current architectural methodology and complies with building regulations and budget limits. Then we present an alternative project that uses low-cost and recycled/recyclable materials to create a building with



Fig. 1. Model A. (a) Plans, (b) Section 1 and (c) elevation.

an energy balance, with an energy efficiency that will reduce the building's power consumption during its lifetime.

### 3. The study

This work forms part of the research project *Interventions in Historical Buildings*, be they classified as monuments or not, and the processes of adapting these edifices to a sustainably developed cultural and economic reality.

This study focuses on residential buildings in the historical city centre of Sevilla [9], in particular a single-family house on two floors

which is a typical example of the architecture of houses constructed in the 18th and 19th centuries in the city.

These types of buildings have been, and still are, undergoing restoration in a process of adaptation to a new social and cultural reality in the city.

#### 3.1. Analysis of the original building (Model A)

It was originally a two-storey house, with five supporting walls and two patios (Fig. 1a and b), both traditional features of residential architecture in Sevilla in the 18th and 19th centuries, with

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