Thermal rehabilitation of residential buildings using solar passive technologies – Conceptualisation and development of the solar bridge retrofit system (SBRS) - an innovative variant of the Trombe wall

PhD student
Sara Brito Coimbra

PhD program
Civil Engineering (FCT, Nova University of Lisbon)

Supervisor
Daniel Aelenei (FCT, Nova University of Lisbon)

Co-supervisors
M. Glória Gomes (CERIS, IST, University of Lisbon) and A. Moret Rodrigues (CERIS, IST, University of Lisbon)

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Summary

Most of the Portuguese residential building stock was built prior to the first Thermal Regulation and is obsolete in terms of thermal comfort. As a result, most of the Portuguese dwellings have poor energy performance. This statement is particularly true regarding their performance during the heating season. One of the main reasons for the poor performance of Portuguese façades is structural thermal bridges at façades, which are areas where thermal energy is significantly lost during the heating season. Additionally, the literature review also showed that:

- Portugal has a great solar potential in the European context, which could be leveraged to enhance the thermal performance of its residential building stock.
- The number of case studies based on solar passive techniques in Portugal is scarce.
- There is a lack of case studies on the assessment and correction of thermal bridges related to the use of solar retrofit strategies in Portugal.

The review studies on Trombe walls also led to the research hypotheses that, by adding an external transparent skin (glazing), it is possible to:

- Reduce the thermal bridge effect.
- Enhance the indoor thermal comfort of residential buildings.

As a result, to correct structural thermal bridge areas, by taking advantage of the Portuguese climate (Mediterranean climate) and by enhancing the thermal performance of residential buildings, a novel Trombe wall, named Solar Bridge Retrofit Solution (SBRS), was proposed. This novel approach of a Trombe wall system targets structural thermal bridge areas of the façade (concrete columns and surrounding masonry wall) and aims to recreate a positive balance of thermal energy to the indoor environment during the heating season. Instead of having higher winter heat losses through the concrete columns than solar heat gains, the proposed system aims to reverse this equation.

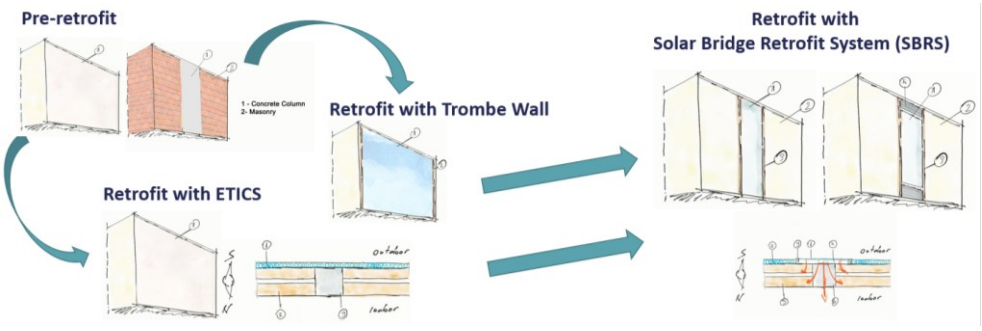
Experimental results from monitoring campaigns on SBRS have shown that:

- The intended thermal balance was achieved (due to the air space between the external transparent skin and the wall, the concrete column worked as a heat gain mechanism).
- Double-glazing performs better than a single-glazing configuration during winter.
- During summer, it is preferable to consider vents on the external transparent skin.

The numerical study allows for assessing the performance of the proposed solution on an annual basis and with different configurations.

Keywords

Solar passive technology, building retrofit, façade design, Mediterranean climate.



Façade design: from existing façade and retrofit solutions to a novel façade design with SBRS.