CERIS Civil Engineering Research and Innovation for Sustainability

SERENE – Optimal Seismic and Energy Retrofit of Buildings considering Economic and Environmental Impacts

Summary

The main goal of SERENE is to propose and demonstrate a framework to integrate, in an optimal manner, the seismic and energy retrofitting of existing buildings, with a view to minimize the resulting economic and environmental impacts.

The seismic performance of the existing building stock can be improved by demolishing and replacing the most at-risk structures with new code compliant ones or by retrofitting to improve their seismic performance. Demolition and replacement of existing buildings is not generally considered an acceptable solution given the high costs of new construction, as well as the extended interruption that it causes to the occupying residents and businesses. In addition to these economic factors, there are significant environmental concerns associated with demolition and reconstruction. The building sector contributes approximately 40% of the total energy use and greenhouse gas emissions in the EU. Construction and demolition waste is also the most significant waste stream in the EU, contributing over approximately 25% to 30% of the EU's total waste. Considering that the economic and environmental costs of retrofitting are lower than demolition and replacement, it is easy to see why this is the preferred option for improving the seismic performance of existing buildings.

Furthermore, an equally large share of the Portuguese building stock is both earthquake-prone and heavily energy-consuming, hence in need for a comprehensive strategy of renovation, due to its structural vulnerability and significant impact on the environment. Nevertheless, retrofit interventions on existing buildings tend to be solely aimed at reducing either energy consumption or seismic vulnerability alone. For these reasons, current EU policies are pushing towards a sustainable renovation of existing buildings, aiming at the mitigation of both their seismic vulnerability and at the improvement of their energy efficiency, something that becomes particularly relevant in many Mediterranean countries, such as Portugal. In addition, the assessment of a building's environmental impact (EI) is becoming increasingly important as owners and developers work to comply with new EI regulations or to obtain green building accreditations. It follows, then, that it is necessary to also consider the EI, with other criteria, such as economic considerations, structural response, energy efficiency and social aspects, when determining optimal retrofit solutions.

SERENE aims to provide a scientifically solid framework to identify the optimal combinations of building retrofitting interventions that will increase the energy and seismic performance of residential buildings in the Portuguese territory (Figure 1). It will achieve so using a multi-criteria decision-making optimization procedure settled on life-cycle based performance metrics. Such metrics will rely on advanced and ad-hoc hazard, exposure and vulnerability models for different building structural typologies. Furthermore, combined retrofitting strategies will guarantee the minimisation of economic and environmental impacts thus targeting increased sustainability and best use of resources. The research scope of SERENE is therefore also fully in line with the country's Sustainable Development plan for the 2030 Agenda.

The project will be carried out by renowned institutions in the country, with consolidated experience in risk assessment and loss estimation of existing buildings and features the participation and support of two European leading institutions, IUSS Pavia, through its ROSE programme and the EUCENTRE, with long-term leading experience in the field of seismic risk and recent experience in the integration of seismic and energy performance of existing structures. SERENE will provide advanced seismic risk models, necessary to define structural retrofitting needs that can be integrated with energy efficiency renovation strategies, promoting sustainability and environmental impact mitigation. The project will focus on residential buildings and attention will also be paid to dissemination of outputs for wider societal exploitation. In addition to the engineering community, the beneficiaries will also be public and private decision-makers) responsible for maintaining and safeguarding the Portuguese residential building stock.

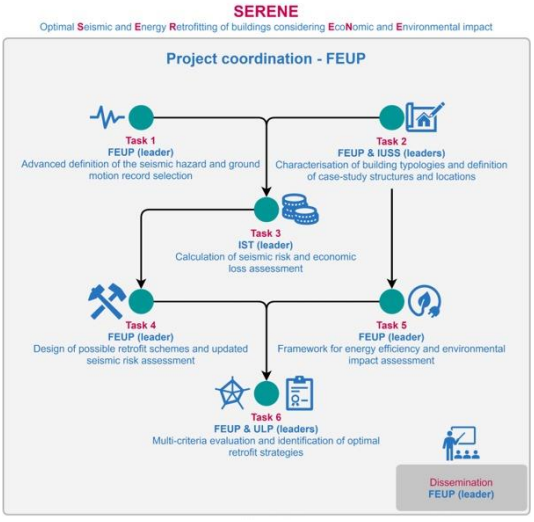

Figure 1. Tasks of Serene Project.

Project Reference

2022.08138.PTDC

Leading Institution

FEUP – Faculty of Engineering of the University of Porto (Portugal)

Partners

IST-ID – Associação do Instituto Superior Técnico para a Investigação e Desenvolvimento (Portugal), COFAC – Cooperativa de Formação e Animação Cultural, CRL (Portugal)

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249 717.47€

CERIS

57 924.00€

Project Website

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