

Rehabilitation of old buildings: reducing seismic vulnerability by reinforcing walls

Summary

Old buildings with load-bearing masonry walls are more vulnerable to seismic actions than buildings built in recent decades, as shown by the damage observed in recent earthquakes in Italy and New Zealand in buildings of similar typology. Masonry buildings are part of the historical fabric of cities, so it is imperative to carry out effective rehabilitation interventions while avoiding the destruction of their identity and intrinsic cultural value. In Portugal, there has been a growing interest, in recent years, in the rehabilitation market, with housing buildings gradually gaining more attention, in particular those that integrate the so-called historic centers. Taking into account the number of old buildings in historic centers that are very degraded, together with the growing interest in their rehabilitation, the search for effective solutions for rehabilitation and structural reinforcement, compatible with the original construction techniques, is increasingly relevant. Reinforced plasters are an adequate reinforcement solution, when it is not possible or required to preserve existing wall coatings, while allowing aesthetic rehabilitation and water protection

In this context, the main objective of this thesis is to contribute to a deeper understanding of the chemical, physical and mechanical characteristics of load-bearing masonry walls of solid clay bricks and air lime-based bedding mortars, as well as to propose effective and compatible reinforcement solutions to be applied to these structural elements. It is intended that the proposed reinforcement solutions, based on reinforced plasters, significantly reduce the seismic vulnerability of the building where the walls are integrated, but also take into account the existing architectural limitations and the compatibility requirements with the original walls. Reinforced plaster is a simple and effective solution for the seismic reinforcement of this type of walls, as it provides an increase in strength and ductility to in-plane shear stresses and out-of-plane bending, an increase in surface resistance and better crack control. To achieve the abovementioned objectives, an extensive experimental campaign was carried out with more than 30 masonry specimens (wallettes) and more than 60 reinforced specimens which allowed: i) the characterization of masonry walls, both in terms of their physical and mechanical global behaviour, and, additionally, through the characterization of its components, collected directly from a building built in 1910, which was undergoing rehabilitation works; ii) the characterization of reinforced coatings and their constituents; and iii) the characterization of reinforced masonry elements to assess the effectiveness of reinforcement solutions. The results obtained allowed us to conclude that the two selected reinforcement solutions guarantee the expected increase in strength in the studied clay brick masonry walls, taking into account that it is intended to improve their seismic behavior. One of the solutions, in addition to improving the mechanical strength around 50% in the cyclic tests of masonry walls at full scale, also presents advantages in the behaviour to water, thus also contributing to the increase of durability and to the improvement of water tightness, aesthetic aspect and the thermal performance of these walls

Keywords

Seismic rehabilitation of old buildings, clay brick masonry walls, reinforced plasters, experimental analysis, mechanical characterization, physical characterization.



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