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TECHNICAL PAPER

Environmentally friendlier strengthening of masonry structure using direct greening system: an experimental study

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Abstract

The green wall benefits from existing buildings have ever more attracted the attention of the scientific community. Past studies mainly focus on the ecological and environmental advantage of existing structures, while few works address the structural benefits of the green wall. In the present study, the structural impact of the typical direct greening system referred to masonry structures is assessed. This experimental program consists of direct shear, flexural bending and in-plane test to evaluate the effect of green walls strengthening effect on the basic characteristic of masonry. For the in-plane test, wall dimensions were $900 \times 750 \times 105$ mm^3 and consisted of 10 brick rows of 4 bricks each. The horizontal load was applied by means of a hydraulic actuator. Results show that after the initial breaking point, the post-peak strength is higher for green walls strengthened panels compared with that of non-retrofitted masonry panel. Even though the green wall strengthened masonry was not showing any improvement in the initial strength, it shows the reasonable improvement in residual strength. Also, it improves the structural behavior in terms of stiffness and energy dissipation capacity. Considering the overall performance, green wall strengthening can effectively improve the residual structural performance of masonry houses. Additional structural performance, to encourage retrofitting, inexpensive and easy to implement technical solutions are desirable. A direct greening system satisfies these requirements.

Keywords Earthquake · Masonry · Seismic retrofitting · Environmental issue · Green wall

Introduction

Masonry structures have a tendency to perform badly in earthquakes due to the low strength of the masonry unit, the low-quality mortar used and the lack of adequate connections between walls. Typically, masonry houses in developing countries are built by house owners themselves or by local masons without any formal engineering supervision. The quality of masonry house construction is often low due to the lack of engineer's supervision involved [1]. Making buildings earthquake-resistant and especially unreinforced masonry structures has not always been easy for earthquake engineers. In order to reduce damage to these unreinforced masonry houses during earthquakes, it is important to strengthen the earthquake resistance of an existing masonry house. Various techniques were used to retrofit the unreinforced masonry buildings. Cost, technology, architectural impact, space reduction, the need for surface finishing, space reduction and occupant disturbance are the major drawback to dealing with the seismic retrofitting methods [2]. In addition, for old historic masonry structures, there are some additional factors to be considered: structure should be retained in their original design, character and architectural view in the process of seismic retrofitting. However, most of the traditional retrofitting methods are not satisfying these factors.

Another major problem is an environmental and sustainable issue related to these retrofitting methods. Generally, manufacturing procedure of retrofitting material used for strengthening masonry structures is not environmentally friendly. Also, at the end of retrofitted structural life, it is difficult to separate the retrofitting materials from masonry walls, when surface finishing applied to the building. Retrofitting material is almost never recycled into new products, so it may dump together with building materials into landfills. It is dangerous to the environment and soil. Table 1 summarizes the drawbacks, the material used and

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