Seismic Retrofitting of Non-Engineering Masonry Houses using Polypropylene Band Meshes

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Abstract: *This paper introduces a retrofitting technique aimed at preventing or prolonging the collapse of adobe (mud brick) houses under strong earthquakes. This technique uses common polypropylene packaging straps to form a mesh, which is then used to encase structural walls. The aim of this paper is to give an overview of the retrofitting technique's development and implementation. The key development stages of static, dynamic and numerical testing are presented, showing that the proposed technique effectively prevents brittle masonry collapse and the loss of debris.*

Keywords: *Masonry, retrofitting, polypropylene band, seismic loading, shaking table test.*

1 INTRODUCTION

More than 60% of people in the world are living in masonry buildings that are made by piling up bricks, sun-dried mud bricks (non fire-burnt brick, generally called Adobe), stone and/or concrete blocks. Population statistics showed that such ratio is rather high, especially in the developing countries. The masonry building without reinforcement against earthquake has claimed scores of victims in the history of all parts of the world. The result of earthquake damage investigations and studies conducted in earthquake-prone regions of the world have revealed that the masonry constructed type buildings would collapse within a few seconds during earthquake movement, and it becomes a major cause of human fatalities.

Generally adobe type structures share two serious structural deficiencies: (1) of having little if any tension strength, and (2) brittleness. Typical earthquake damage patterns of earthen housing include:

- Poor connections between the different elements of the building that lead to walls separating at corners and falling outwards
- Diagonal cracking in walls. This weakens them and leaves them very vulnerable to total collapse.
- Out-of-plane failure of walls due to lack of cross walls
- Roof collapse

These types of damage are serious. They lead to severe injuries and loss of life. Furthermore, they can occur at low intensities of earthquake shaking depending on the quality of construction materials and their maintenance. Therefore, retrofitting low earthquake-resistant masonry structures are a key issue for earthquake disaster mitigation in developing countries.

1.1 Currently available retrofitting techniques for masonry

Several types of retrofitting methods have been developed for unreinforced masonry structures. A comprehensive review of them can be found in Blondet, M. et al (Blondet, M. et al, 2011). There is no doubt that these methods are useful for strengthening masonry structures. The methods required to meet the needs of the large populations in danger of non-engineered masonry collapse must be simple and inexpensive to match the available resources and skills. Considering above factors and lack of unreinforced masonry structural integrity, technically feasible and economically affordable retrofitting technique utilizing different type of meshes has been developed and many different aspects have been studied. The main objectives of this technique are to hold the disintegrated elements together thus