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Strengthening of adobe houses with arch roofs using tie-bars and polypropylene band mesh

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HIGHLIGHTS

- Effects of PP-band and tie-bars retrofitting have been experimentally investigated.
- Arch with only tie-bars was clearly shown a collapse pattern with the thrust force.
- Arch with PP-band retrofitting maintained wall integrity for large deformations.
- Presence of tie-bars in PP-band retrofitting improves this performance of the arch.

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ABSTRACT

The purpose of this study was to compare the effects of strengthening adobe houses with an arch roof using polypropylene band (PP-band) mesh with or without tie-bars. To this end, an experimental analysis was conducted on scale models of adobe houses. In one test, an arch roof was retrofitted with only a PP-band mesh. In the second test, in addition to being retrofitted with PP-band mesh, tie-bars were used for horizontal support at roof level. These two PP-band retrofitted house models and house model with tie-bars only were subjected to sinusoid loading until the point of collapse or the capacity of the shaking table was exceeded. Results collected during the analyses were significant in assessing the capability of these retrofitting methods to support dynamic loads, increasing the collapse load, stiffness and ductility and dissipate energy.

1. Introduction

The results of earthquake damage investigations have revealed that adobe structures collapse within a few seconds during earthquake movement and become a major cause of human fatalities. The collapse of walls, roofs and ceilings and the spread of suffocating dust at the time of collapse are key factors that typically contribute to a wide range of human casualties.

The recent earthquake in the Bam region of the Kerman state in southeast Iran on 26 December 2003 resulted in an estimated 23,000 human casualties. The earthquake demonstrated the effects on adobe materials used in a dome or arch type of roofs and the thick walls traditionally used since ancient times. Buildings of this type can be found not only in Iran, but also throughout countries in the Middle East. Since the olden days, roof design has been influenced by culture and religion. However, the unreinforced adobe structures with arch roofs are generally characterized by weak, brittle materials, weak connections and excessive weight. In order to reduce damage to these adobe buildings during earthquakes, it is important to identify methods for improving and upgrading the earthquake resistance of existing adobe buildings. The failure of arch structures under a given loading condition is generally dependent on the geometry of the arch and on the mechanical characteristics of the materials used in construction. Three possible failure types (Fig. 1) were discussed by Foraboschi [1] and include:

- Failure by crushing.
- Failure by sliding of components.
- Failure by the hinge mechanisms that join the arches.

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