EXPERIMENTAL STUDY ON PP-BAND MESH SEISMIC RETROFITTING FOR LOW EARTHQUAKE RESISTANT ARCH SHAPED ROOF MASONRY HOUSES

NAVARATNARAJAH SATHIPARAN
Post Doctoral Fellow, The University of Tokyo, Japan
sakthi@risk-mg.iis.u-tokyo.ac.jp
PAOLA MAYORCA
Project Research Associate, ICUS, Institute of Industrial Science,
The University of Tokyo, Japan
paola@iis.u-tokyo.ac.jp
KIMIRO MEGURO
Director/ Professor, ICUS, Institute of Industrial Science,
The University of Tokyo, Japan
meguro@iis.u-tokyo.ac.jp

ABSTRACT

Unreinforced masonry structure is one of the most popularly used constructions. It is also unfortunately the most vulnerable to the earthquakes. It would collapse within a few seconds during earthquake movement, and does become a major cause of human fatalities. Therefore, retrofitting of low earthquake-resistant masonry structures is the key issue for earthquake disaster mitigation to reduce the casualties significantly. When we propose the retrofitting in developing countries, retrofitting method should respond to the structural demand on strength and deformability as well as to availability of material with low cost including manufacturing and delivery, practicability of construction method and durability in each region. Considering these issues, a technically feasible and economically affordable PP-band (polypropylene bands, which is commonly utilized for packing) retrofitting technique has been developed and many different aspects have been studied by Meguro Laboratory, Institute of Industrial Science, The University of Tokyo.

Unreinforced masonry structures with masonry arch shaped roofs are generally characterized by weak, brittle materials, weak element connections and excessive weight. The main points of weakness of the traditional masonry arch roofs that contributed to poor seismic response can be inability of the roof to act as a diaphragm and heavy weight of the roof. But ability of PP-band mesh kept the structure integral during the shaking will help to overcome this issues. Therefore, to evaluate the beneficial effects of the PP-band mesh retrofitting method, shaking table tests were carried out on arch shaped roof masonry structure with and without retrofitting.

From tests' results, a scaled model with PP-band mesh retrofitting is able to withstand larger and more repeatable shaking than that without PP *band retrofitting, which all verified to reconfirm high earthquake resistant performance. Therefore proposed method can be one of the optimum solutions for promoting safer building construction in developing countries and can contribute earthquake disaster reduction in future.*

1. INTRODUCTION

Unreinforced masonry structures with masonry arch roofs are generally characterized by weak, brittle materials, weak element connections and excessive weight. The main points of weakness of the traditional masonry arch roofs that contributed to poor seismic response can be summarized as follows:

- Inability of the roof to act as a diaphragm: Masonry arch roofs are incapable of diaphragm action. This is due to their curved geometries, the load-carrying mechanisms and the weak and brittle materials. The load-carrying mechanism of these types of roofs is primarily in compression. The non-homogeneous masonry of the roofs is unable to carry tensile or flexural loads. As a result, they are not capable of restraining the top of their supporting walls during ground shaking, nor are they capable of transferring excessive horizontal inertia forces. Furthermore, they induce a pre-earthquake static horizontal force at the top of the walls as they transfer their compressive load to the walls. In the shared load-bearing walls, the thrust from the two adjoining arches cancel each other out. However, in end arches this force causes an unbalanced outward thrust on the wall.
- Heavy weight of the roof: Perhaps the most important seismic weakness of the masonry arch is their excessive weight. The masonry arch roofs are, by nature heavy, as a minimum roof thickness is required to enable the successful transfer of the gravity load in an arch action.

2. EXPERIMENTAL PROGRAM

2.1 Description of the specimens

For shaking table experiment, three models were built in the reduced scale of 1:4 using the unburnt brick as masonry units and cement lime and sand (1:2.8:8.5) mixture as mortar with cement/water ratio of 0.33. Attention was paid to make the models as true replica of adobe masonry buildings in developing countries in terms of masonry strength even though the construction materials used were those available in Japan.

Buildings dimensions were 933mmx933mmx720mm box shape with 380 mm height arch shape roof as shown in Figure 1. Wall thickness is 50mm. The sizes of door and window in opposite walls were 243x485mm^2 and 325x245mm^2 respectively.