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Shaking Table Experiment of Masonry Buildings and Effectiveness of PP-Band Retrofitting Technique

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1. Introduction

Human casualties due to earthquakes in the 20th century are mostly due to structural damage and most of which are from unreinforced masonry buildings (Coburn and Spence, 2002). Therefore, retrofitting of low earthquake-resistant masonry structures is the key issue for earthquake disaster mitigation in developing countries to reduce the casualties significantly. Seismic retrofitting reduces not only the damage to buildings during earthquakes, but also the costs of rescue and first aid activities, rubble removal, temporary residence building, and permanent residence reconstruction to re-establish normal daily life (Yoshimura and Meguro, 2004).

An appropriate retrofitting technique for developing countries should consider not only its efficiency in terms of improvement of the seismic resistant characteristics of the structures but also economical affordability, cultural acceptability and material as well as technological availability. An appropriate seismic retrofitting technique, PP-band retrofitting technique for masonry buildings has been developed and different aspects are being researched in Meguro Laboratory, in the Institute of Industrial Science, The University of Tokyo for some years considering these issues (Mayorca and Meguro, 2004). This year, shaking table experiments were carried out to understand the dynamic response of masonry buildings, crack propagation, failure behaviour, and overall effectiveness of the newly developed retrofitting technique.

2. Specimens Construction

For shaking table experiment, two models were built in the reduced scale of 1:4 using the burnt bricks as masonry units and cement, lime and sand (1:8:20) mixture as mortar with c/w ratio of 14%. Attention was paid to make the models as true replica of brick masonry buildings in developing countries in terms of masonry strength even though the construction materials used were those available in Japan. Both the models represented a one-storey box-like building without roof. This simple geometry and boundary conditions were considered as the data generated will be used for numerical modelling in future. Both the buildings dimensions were 950mm × 950mm × 720mm with 50mm thick walls. The sizes of door and window in opposite walls were 243 × 485mm^2 and 325 × 245mm^2, respectively.

Table 1: Mechanical Properties of Masonry

Property	N-B-40	R-B-40
Compressive strength (MPa)	20.96	20.30
Shear strength (MPa)	0.074	0.075
Bond strength (MPa)	0.085	0.074
Diagonal compression strength (MPa)	0.173	0.181

One of the buildings was retrofitted with PP-band mesh after construction. The geometry, construction materials and mix proportion, construction process and technique and other conditions that may affect the strength of the building models were kept identical for better comparison. The cross-section of the band used was 6x0.24mm2 and the mesh pitch was 40mm. The retrofitting procedure is described in section 3 of this paper. In this paper, the non-retrofitted model is named as “N-B-40” and the retrofitted one “R-B-40”. The mechanical properties of masonry in terms of compressive, shear and bond strength were similar in both the cases and are given in Table 1.

3. Retrofitting Process

Most of the residential buildings in developing countries are of non-engineered type and owner built. In some developing countries with higher seismic hazard, more than 90% of the buildings are non-engineered. In such situation, homeowners and local craftsmen play the pivotal role in the building production mechanism (Dixit, 2004). So the implementation procedure for retrofitting

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