Master's Thesis

Experimental Study on Simple Retrofitting Method for Hollow Blocks Masonry Walls

穴あきブロック壁構造のシンプルな耐震補強工法の研究

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Abstract

Masonry is one of the most used construction materials for its availability, affordability, fire resistance, and thermal mass. Concrete Hollow Block (CHB), as a masonry unit, has recently become a popular material for residential buildings in Southeast Asia, mainly in the Philippines. Most of the buildings are constructed without engineers' involvement, which is commonly called the "Non-Engineering Building." Unreinforced Masonry (URM) building is highly vulnerable during the earthquake; it contributes to a massive number of casualties. Moreover, URM has been constructed extensively in earthquake-prone areas. Therefore, increasing seismic capacity for existing and new masonry houses become one of the most urgent issues for earthquake disaster mitigation in recent years. Besides, seismic retrofitting can also significantly reduce the recovery cost after the disaster; for example, search and rescue activities, debris removal, and reconstruction.

Most of the CHB manufactured and used are vulnerable during the earthquake because it has low compressive strength. Here, a retrofitting method using fiber as the primary reinforcing material is employed. The fibers are in the form of liquid paint, which is easy to apply and beautify the appearance of houses. In this study, shaking table tests have been conducted to investigate the benefit of fiber-reinforced paint. Three 1:4 scale house models were built: 1) unreinforced house model (URM), 2) reinforced by steel bars (rebar), and 3) fiber-reinforced paint (paint) house model.

A simple and easy-to-use sinusoidal motion with frequencies ranging from 2 to 35 Hz and amplitudes ranging from 0.05 to 1.4 g was applied to the structures to obtain the dynamic responses. It was found that the complete collapse of the URM masonry house model occurred at run 43, for the rebar model at run 49, and the paint model at run 54. The fiber-reinforced paint house model was shaken with higher input energy until some more run. It suggests that the fiber-reinforced paint model can handle large deformations and more repeatable shaking than other models. Moreover, the energy dissipation of the fiber-reinforced paint house model is larger than other models.

By using this method, the amount of dust produced from the vibration could be significantly reduced. It is beneficial to minimize the number of casualties from suffocation during the earthquake. This method exhibits very robust performance even in the high input motion at seismic intensity JMA 7 (Japan Meteorological Agency). It proves that this retrofitting method has a high earthquake-resistant performance.

Keywords: Concrete Hollow Block, Unreinforced Masonry, fiber-reinforced paint, shake table test